CROP PROTECTION PROGRAMME

Project Title (Production of *Pasteuria penetrans* to control root-knot nematodes (Meloidogyne spp.)
R8218 (ZA 0533)

FINAL TECHNICAL REPORT

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FINAL TECHNICAL REPORT

Executive Summary

Root-knot nematodes are a major constraint to vegetable, fruit and flower producers in Kenya. More than 1 million rural farmers are involved in the horticultural production for home and export markets. Environmentally benign methods for managing these nematodes are urgently needed to sustain productivity in permanently cultivated smallholdings and also to meet the increasingly demanding production and quality requirements being promoted through European Union initiatives. One promising technique for managing root-knot is the through the deployment of a naturally occurring bacterium, *Pasteuria penetrans.* Building on technology developed in previous DFID-funded projects this project has sought to develop a protocol by which *P. penetrans* can be mass-produced on a commercial scale to enable its widespread use by farmers within a broader integrated pest management system. Root-knot nematodes were sampled from 509 sites in three important production districts, Timau, Naivasha and Mwea. From this survey of root-knot infestations juvenile nematodes encumbered with spores of *P. penetrans* were found from just four samples, one from Timau and three from Naivasha. No *P. penetrans* was found at Mwea. It was appreciated that failure to detect the bacterium could be due to deficiency in the sampling and assessment rather than absence from a particular location. Populations of the Timau and Naivasha *P. penetrans* isolates were established on cultures of root-knot nematodes and a system of mass-production was initiated. This system has been scaled–up at a purpose–built facility in Naivasha. When commissioned, this system based on *in vivo* production will yield spores of *P. penetrans* that will be made available to farmers wishing to participate in integrated management systems and those specialist farmer groups committed to organic production. The system of nematode management to be promoted to farmers meets the requirements of the new initiatives on use of pesticides and the Good Agricultural Practice (GAP) of the EU supported Pesticide Initiative Programme (PIP).

Background

Root Knot Nematodes (RKN) have a worldwide distribution and are pests of more than 2000 plant species. They are significant pests of vegetable and flower crops causing gall formation on roots which, disrupts normal functioning of the roots leading to stunted plant growth and low yields. They also disfigure root stem tubers thereby reducing their market value. There are several species of RKN the commonest are *Meloidogyne hapla*, *M .javanica*, *M. incognita* and *M. arenaria*. Root knot nematodes all have a short life cycle of 25-28 days at 25 ^{0}C and a very high reproductive rate of 500-2000 eggs/female. The high rate of reproduction contributes to RKN being hard to control.

Conventional control of RKN is with chemical-based nematicides, this control method has often been characterised by excessive use of pesticides in the intensive land use systems of both resource poor and commercial farms. Typically, the home and export horticulture market in Kenya is responsible for the livelihood of 1,000,000 rural people. The use of chemicals (particularly nematicides) is increasingly being discredited for reasons of toxicity, environmental hazards and pollution. As production agriculture is placed under ever increasing pressure to reduce its pesticide input, an Integrated Pest Management (IPM) approach with minimal chemical pesticides and bio-control becomes an increasingly attractive option. One of the methods to control RKN in an IPM system is with *P. penetrans* (Pp).

Previous DFID funded projects (Integrated management of root-knot nematodes on vegetables in Kenya (ZA 0324 7472) and Biological control of root-knot nematodes 1996-

1999 (R6611) identified Pp as having potential for control of RKN in Kenya. This potential needed to be developed to make Pp available on a scale appropriate to growers.

Project Purpose

The project purpose was to develop commercial grower protocols for use of Pp technology, building on Pp technology developed in previous DFID funded projects by Kenyan Agriculture Research Institute (KARI) and CABI. For the project, Dudutech (Kenya) Limited (Dudutech) aimed to survey for RKN and Pp on commercial production land, mainly within the farms of Homegrown Limited (a commercial flower and vegetable export grower in Kenya) and their outgrowers (small scale farmers). Isolates of RKN and Pp discovered would then be mass produced. Protocols developed for this would be made available to growers so they could develop a RKN control method based on Pp. This work is in support of the promotion of pro-poor strategies to reduce impact of key pests, improve yield and quality of crops and reduce pesticide hazards in peri-urban systems.

Research Activities

Dudutech, in collaboration with Reading University aimed to develop the bacterial parasite Pp as a bio-control agent for RKN. The work focused on collection of Pp isolates for use in glasshouse and field experiments, and to bulk-up Pp for use in the field. As part of the collaborative activity, the University of Reading organised two weeks visit/training to their laboratories for the Dudutech personnel working on the project prior to the commencement of the work.

Establish Kenyan Pasteuria penetrans.

Review the farm records for areas with RKN

A soil survey was done to isolate and determine the distribution of naturally occurring populations of Pp in selected sites on farms in Nanyuki, Naivasha and Thika: using the block/crop history of the selected farms, the blocks that had high levels of RKNs were identified. A 'blind' search was also done, where no records were available. Blocks with crops susceptible to RKN and with crops approaching maturity were selected. A total of 509 samples were collected from farms in Naivasha (dry hot climate 1900m. above sea level) and Timau (cold 2100m above sea level, Mount Kenya region) and Mwea (Appendix 1).

Collection of root and soil samples from fields

Using a soil auger/panga/trowel the first 5cm were scrapped off and soil collected up to a depth of 25cm across each field along a 'M' or 'W' pattern. A total of 20 sub samples were collected per block of 1ha. These were mixed thoroughly and a composite 1 Kg obtained and sent to the laboratory. A minimum of 10 plants were collected from each block.

Extraction of RKN from samples, Confirmation of RKN presence and *P. penetrans* detection

The methods used to extract *Meloidogyne* spp. second stage juveniles from the soil were decanting, sieving and filtration method and by using a modified Baermann's technique. The extract was incubated for 36 hours. For root materials, an adapted Whitehead tray technique was used and extracts incubated for up to 48 hours depending on the crop. Harvesting was done by passing the nematode suspension 2 or 3 times through a 45 µm sieve and suspensions of 15-20 ml collected in universal bottles. Confirmation of second-stage juveniles (J_2) presence was done by examination of samples under an inverted microscope at x200 magnification. For all the samples, the first 20 J_2 were observed to detect Pp spores which attach to the J_2 cuticle. At the end of this review exercise various RKN populations were found to exist in the different areas sampled within the different ecological zones. Generally RKN occurrence was found to be high (> 150 juveniles/100cc) in the flower blocks as compared to very (<75 juveniles /100cc soil) found on the vegetable blocks. Pasteuria penetrans spores were also observed attaching to juveniles from five of the samples assessed in varying numbers.

Establish RKN on clean plants
In the glasshouse clean RKN populations from the 3 different ecological zones (Timau, Naivasha and Mwea were established and maintained through the project on tomatoes (var. money maker and later Tiny Tim) and lettuce. Soil that remained after extraction was used to make the potting medium, the juveniles that were extracted were later used for inoculations.

Develop system for establishing Pp cultures.
Through sampling and assessment the first site positive for Pp was Timau block-G11; this had two juveniles with 1 spore each. A second checking got 1 juvenile with 1 spore. The other positive sites found were Naivasha-houses 10, 25, 69 and 22. Mwea site was excluded from any further assessment as it was found negative for Pp. A more strategic sampling continued on all the positive sites to collect more spores.

For block G 11 further searches were not successful, as the block had been pulled down, Houses 10 and 25 too were unsuccessful. No further work was carried out on these two sites. Houses 69 and Rose 22 remained positive. Due to the greater occurrence of Pp in this Rose House 22 and block G 11 ; a strategic sampling was carried out and a Pp positive spot map developed (Appendix 2 and 3).

Soil bioassays were also done with 250 cm^3 being wetted and introduced with freshly hatched juveniles to collect more spores from the soil, this however did not give any positive results.

All soils remaining after extraction were used to make potting media in the greenhouse at ratios of 3:1:1 (soil: sand: ballast). The pots were planted with tomatoes var. Moneymaker and after 4 weeks the suspension with the infested juveniles was inoculated. This was left to grow for 8 weeks before they were harvested and root dried to be assessed for Pp infection. At harvest all the G 11 and H22 pot plants had RKN females infected with Pp spores.

Confirm presence of Pp on nematode cadavers, cultivate initial stocks and store 'mother' cultures
After growing for two months, the roots were harvested, soils washed off and air-dried before grinding using a coffee mill. A few grams of the root powder was wetted in a Petri dish and left for some hours. Using a dissecting microscope, females were picked out and placed in a drop of water. The females were squashed and observed for infection using an inverted microscope. Females found to be infected were collected in universal bottles and labelled. The spore suspension was used to attach more juveniles for the next phase of multiplication.

Develop knowledge of activity of Pp against RKN
Endospore-filled female cadavers were placed into 0.2 ml drop of distilled water in a Petri dish and crushed using a glass rod. The spore suspension was rinsed into a universal bottle. Freshly hatched juvenile nematodes were introduced into the suspension at ratios of 1000 juvenile/ml and incubated at 25 ^oC for 18 hours. Endospore attachment rates of 100% were obtained on RKN juveniles after 18 hours with mean attachment ranging from 6-10 spores (Table 1).

Table 1: Pp endospore attachment to RKN J_2 (number of spores per juvenile)

	Endospore attachment/juvenile								
Count No.	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F	Sample G	Sample H	Sample I
1	9	6	5	10	5	8	6	7	9
2	9	15	10	8	5	12	11	8	12
3	7	14	12	8	3	10	3	4	13
4	9	12	4	4	9	8	6	4	9
5	6	4	10	7	12	2	7	10	10
6	7	2	7	3	6	10	4	8	8
7	5	10	8	8	7	8	7	8	7
8	4	8	9	9	2	7	10	7	11
9	3	9	8	7	9	12	5	7	14
10	6	10	6	2	13	10	12	8	12
11	7	7	4	8	2	11	8	7	10
12	0	10	8			9	15	9	13
13	11	6	10			6	1	10	8
14	8	8	8				12	4	9
15	6	9	7				3	4	10
16			4				13	12	6
17			11				5	5	4
18			7				7	9	9
19			13				8	9	10
20			12				9	5	12
21			7						
mean	6	9	8	7	7	9	7	7	10

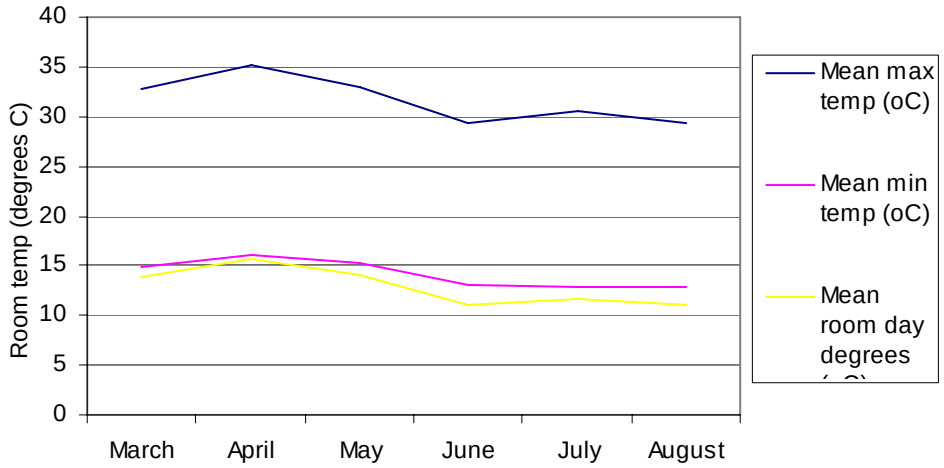
Mass Production of Pp

Tomato var. Moneymaker and Tiny Tim were planted into 1 litre pots, on establishing (after approximately 4 weeks), these were inoculated with 2000 Pp endospore encumbered juveniles with a minimum of six spores/juvenile. The plants were maintained in the greenhouse for a minimum of 40-45 days (at temperatures of between 28-30 ^{o}C) or longer if lower average temperatures were recorded. The low night temperatures experienced between March and August resulted in a total growth period of 4 months before harvesting. On maturity, the roots were harvested and air-dried for two weeks; these were later cut into pieces with scissors and a domestic electric coffee mill used to grind them for 1 to 2 minutes.

The set backs experienced in the actual maintenance of the crop in the green house during this period were an infestation by sciarid flies towards the end of April that caused the death of a number of inoculated plants. Some level of control for this pest was achieved by the introduction of yellow sticky traps in the pots. An infestation by Tomato Russet mites also caused the wilting of a number of plants, the pest was controlled by the application of Dynamec® at 25 ml/100 l. Intermittent Powdery mildew infection of the crop was kept under check by the application of the broad-spectrum fungicide Benlate® at 20 g/15 l.

Low mean greenhouse temperatures between the month of March and August (Figure 1) resulted in a delayed scaling up of the greenhouse production of Pp.

Figure 1: Mean monthly greenhouse temperatures.



Quality Assurance Procedure

Preparation and calibration of spore suspensions

A 1 g sample of root powder inoculum was weighed out and ground with a little tap water for a minimum of two minutes using a mortar and pestle. The slurry was washed off from the mortar into a storage bottle and the volume made up to 1000 ml with tap water; this was stored in a refrigerator at 4 to 8 ^{o}C until required. Calibration of spore suspension was done using an improved Neubauer Haemocytometer (0.25 mm depth1/16mm^{2}). Spore populations were estimated by obtaining the mean count of a minimum of the four large squares (table 2). Mean spore concentration per female was obtained as 1.56x10^{6}. Spore concentration from propagation house root powder samples were higher (mean of 6.56x10^{6}) than those obtained from greenhouse samples (mean 3.26x10^{6}).

Table 2: Calibration of spores

Isolate code	Production site	Suspension type	Spore count
H22	Green house pot	Female	4.69 x 10^5/female
H22	Green house pot	Female	1.09 x 10^6/female
mean			**1.56 x 10^6**
G11	Green house pot	Root powder	2.31 x 10^6/g
G11	Green house pot	Root powder	1.9 x 10^6/g
H22	Green house pot	Root powder	4.47 x 10^6/g
H22	Green house pot	Root powder	3.75 x 10^6/g
H22	Green house pot	Root powder	3.75 x 10^5/g
H22	Green house pot	Root powder	6.78 x 10^6/g
mean			**3.26 x 10^6**
G11	Prop house pot	Root powder	7.97 x 10^6/g
H22	Prop house pot	Root powder	5.93 x 10^6/g
H22	Prop house pot	Root powder	5.78 x 10^6/g
mean			**6.56 x 10^6**

A 0.1 g sample of the root powder was weighed out and wetted for 2 hours, single endospore filled females were picked out and crushed in tissue grinder, the spore suspension was rinsed off into a universal bottle and water added to make up 2 ml. 200 freshly hatched juveniles were added and allowed to stand for 18 hrs at 25 ^oC. Counts of the first 20 juveniles were made for numbers of attached spores. This information was used to calculate % attachment potential As in table 1 above

A 0.5 g sample was picked out from every batch of root powder and stored in micro tubes; these are being used to assess attachment potential over time to determine storage capacity.

Optimise Pp use by small plot field trials

The root powder obtained from propagation and green house pots was assessed for presence of Pp endospore and then used to encumber more juveniles to further bulk up. A batch of 100 pots were set up at Flamingo farm, Naivasha in the months of September and October 2003, these roots were harvested in January 2004 air dried and ground to yield a total 200 g root powder (Appendix 4). Hourly temperatures were recorded all through the growing period using a data logger set in one of the experimental pots.

Grower and demonstration trials

In February 2004, upon the completion of the construction work in the production tunnels in Naivasha, 400 pots were set up with the Tomato variety Tiny Tim these were with Pp encumbered juveniles and grown for 2 months. A weekly introduction of 100 pots followed by inoculations to be maintained in the tunnel through the year.

In the second tunnel, demonstration strips of different crops (carrot, tomatoes will be set up with treatments of Pp and other control methods in a typical rotation system for the next one and a half years for the management of RKN on these high value crops.

Outputs
The anticipated outputs were achieved for this project, the results and details of continuing work are given below.

During the project four isolates of Pp were found, two of these has been put into large scale production in tunnels at the Dudutech Kingfisher field site: initially 400 Tomato plants var. Tiny Tim were inoculated with Pp spore encumbered juveniles. Subsequently a production system of 100 inoculated plants per week was set up with an expected dry root powder yield of 200 g per week. Production on heated benches in the propagation house using 200 cc pots have also been set up.

Inoculated demonstration plots involving commonly used grower rotations have been set up with a rotation plan consisting of carrots, baby corn, Tomato, Broccoli and finally carrots. This will be maintained on the ground for a total of 18 months at the Dudutech Kingfisher farm, each crop will be assessed both at the laboratory and graded in the commercial pack house for market value.

Working protocols for the greenhouse, propagation house and field production of Pp have been developed and are in use at the Dudutech Biorational production unit. Production protocols are currently being further refined.

The Dudutech (Kenya) Ltd training department also conducted a series of training courses in Integrated Pest Management (IPM), the information obtained during the project was a core component of the training package.

The interaction between the agent and the pests was also demonstrated in the laboratory to the visitors to the Dudutech Laboratory. Presentations and updates on *Pasteuria penetrans* work were made to the following groups; Kenyan and East African horticulture producers (Vegpro, Hortico, Zweisloots, Homegrown), UK supermarket representatives (Marks and Spencer, Tesco, Sainsbury, Safeways), Kenyan technical institutes (ICIPE, KARI, NARC, KEPHIS) and technical visitors from Cuba, Peru, UK.

A detailed characterisation of the root knot nematode isolates used in this project was not carried out. This will however need to be carried out in order to develop a more specific user protocol.

Contribution of Outputs to developmental impact
The project leader, representing a biopesticide-producing company, appreciates that there will be an increasing demand for a safe method of managing root-knot nematodes. Dudutech (Kenya) Ltd is prepared to invest in the development of these biopesticides and take forward some of the preliminary outputs of the DFID Crop Protection Programme with a view to making them available to all sectors of the Kenya horticultural industry. Such developments could not progress without the approval of the National regulatory authority. The DFID-CPP support for the workshop that led to the drafting of the amendments to the pesticide legislation of a regulatory framework specifically for biopesticides has been a fundamental outcome during the life of this project.

Dudutech has begun to mass-produce *P. penetrans* at its biopesticide production facility in Naivasha. Work will still be necessary to perfect the production protocol and necessary quality controls. Some further prospecting for *P. penetrans* isolates may be necessary. The product will be made available to all commercial growers and training courses are planned for Dudutech/Homegrown scientists, commercial vegetable and flower producers and scientists from the national programmes. At a different level, demonstration plots and field days will be organised for smallholders particularly the contracted out-growers supplying the export companies and the organic growers registered with the Kenya Institute of Organic Farming (KIOPF).

Dudutech will continue to invest in biopesticides and hope to collaborate with donors and other organisations in the further exploitation of biocontrol agents.

Biometricians Signature

I confirm that the biometric issues have been adequately addressed in the Final Technical Report:

Signature:
Name (typed): Dr Eleanor Allan
Position: Statistical Advisory Service, The University of Reading
Date:

Appendix 1: Farm Root Knot nematode history

Lab Id	Date Of Sampling	Farm Id	Block Id	Previous Crop	Crop On Ground	Age Of Crop	Pp Status	Comments
1	29/04/2002	Turacol	A 2				negative	few juveniles
2	29/04/2002	Hornbill	H 3				negative	few juveniles
3	29/04/2002	Hornbill	H 11				negative	many juveniles
4	29/04/2002	Hornbill	H 2				negative	many juveniles
5	29/04/2002	Hornbill	F 3				negative	few juveniles
6	29/04/2002	Amani	L 34				negative	many juveniles
7	29/04/2002	Malachite	M 27				negative	many juveniles
8	29/04/2002	Tacazze	U 27				negative	many juveniles
9	18/05/2002	Flamingo	Hse 22		Rose-Duette		negative	no juveniles, block furadan treated
10	18/05/2002	Kari	Hse B 1		Carnation		negative	no juveniles, block furadan treated
11	18/05/2002	Kari	Hse 11		Carnation		negative	many juveniles
12	18/05/2002	Flamingo	Hse 67		Lesianthus		negative	no juveniles
13	18/05/2002	Flamingo	Hse 22		Rose-Golden gate		negative	no juveniles
14	20/05/2002	Hornbill	G 3				negative	many juveniles
15	20/05/2002	Tacazze	U 40				negative	few juveniles
16	20/05/2002	Tacazze	U 41				negative	few juveniles
17	20/05/2002	Tacazze	U 39				negative	few juveniles
18	20/05/2002	Tacazze	U 21 A				negative	few juveniles
19	20/05/2002	Amani	A 6				negative	few juveniles
20	20/05/2002	Amani	A 8				negative	few juveniles
21	20/05/2002	Amani	A 13				negative	few juveniles
22	20/05/2002	Amani	A 20				negative	few juveniles
23	20/05/2002	Timau	Garden		Sage		negative	many juveniles
24	20/05/2002	Timau	Garden		Brocolli		negative	no juveniles
25	20/05/2002	Timau	Garden		Parsely		negative	no juveniles
26	20/05/2002	Timau	Garden		Physallis		negative	many juveniles

27	20/05/2002	Timau	Garden		Mint		negative	many juveniles
28	20/05/2002	Tacazze	U 53 A				negative	no juveniles
29	20/05/2002	Tacazze	U 37				negative	no juveniles
30	20/05/2002	Amani	L 5 B				negative	no juveniles
31	05/06/2002	Pelican	Hse 10		Rose		negative	many juveniles
32	05/06/2002	Flamingo	Hse 67 B		Lesianthus		negative	many juveniles
33	05/06/2002	Hornbill	G 5		Carrot		negative	few juveniles
34	06/06/2002	Tacazze	U 25				negative	few juveniles
35	06/06/2002	Tacazze	U 14				negative	few juveniles
36	06/06/2002	Tacazze	U 26				negative	few juveniles
37	06/06/2002	Turacol	A 5				negative	no juveniles
38	06/06/2002	Turacol	B 25				negative	no juveniles
39	06/06/2002	Turacol	B 26				negative	no juveniles
40	12/06/2002	Naivasha	Hse 2				negative	few juveniles
41	12/06/2002	Naivasha	Hse 10				negative	few juveniles
42	12/06/2002	Malachite	M 20				negative	no juveniles
43	12/06/2002	Malachite	M 40				negative	few juveniles
44	12/06/2002	Amani	L 6				negative	no juveniles
45	12/06/2002	Hornbill	G 5				negative	few juveniles
46	12/06/2002	Hornbill	G 4				negative	few juveniles
47	12/06/2002	Tacazze	U 1				negative	many juveniles
48	12/06/2002	Hornbill	G 3				negative	no juveniles
49	12/06/2002	Hornbill	G 13				negative	no juveniles
50	12/06/2002	Hornbill	G 11				negative	few juveniles with hair like projections
51	12/06/2002	Hornbill	G 12				negative	no juvenile
52	12/06/2002	Hornbill	G 14				negative	no juveniles
53	12/06/2002	Tacazze	U 54				negative	no juveniles
54	12/06/2002	Tacazze	U 5				negative	few juveniles
55	12/06/2002	Tacazze	U 6				negative	few juveniles
56	12/06/2002	Tacazze	U 46				negative	no juveniles
57	12/06/2002	Embori	C 1				negative	no juveniles
58	12/06/2002	Embori	B 10				negative	few juveniles

59	12/06/2002	Embori	C 11				negative	no juveniles
60	12/06/2002	Embori	C 2				negative	no juveniles
61	12/06/2002	Embori	B 8				negative	no juveniles
62	12/06/2002	Embori	B 7				negative	no juveniles
63	12/06/2002	Embori	B 9				negative	no juveniles
64	18/06/2002	Flamingo			Rose		negative	few juveniles
65	18/06/2002	Flamingo			Rose		negative	many juveniles
66	20/06/2002	Pelican	Hse 10				negative	many juveniles
67	20/06/2002	Pelican	Hse 11				negative	many juveniles
68	20/06/2002	Pelican	Hse 10				negative	many juveniles
69	25/06/2002	Hornbill	H 4				negative	many juveniles
70	25/06/2002	Hornbill	H 10				negative	no juveniles
71	25/06/2002	Hornbill	H 9				negative	few juveniles
72	25/06/2002	Hornbill	G 20				negative	no juveniles
73	02/07/2002	Tacazze	U 1-Kingfish				negative	few juveniles
74	02/07/2002	Amani	B 10				negative	few juveniles
75	**02/07/2002**	**Amani**	**A 20**				**positive**	**1 juvenile with 1 spore**
76	02/07/2002	Hornbill	G 18				negative	many juveniles
77	02/07/2002	Hornbill	G 17				negative	many juveniles
78	**02/07/2002**	**Hornbill**	**G 11**				**positive**	**one juvenile with 1 spore, few juveniles**
79	02/07/2002	Hornbill	G 15				negative	no juveniles
80	03/07/2002	Pelican			Carnation-Guanse		negative	few juveniles
81	03/07/2002	Pelican			Carnation-salmolytandem		negative	Many juveniles
82	03/07/2002	Pelican	Hse 11		Carnation-Cerise		negative	few juveniles
83	03/07/2002	Pelican	Hse 10		Carnation-Autumn		negative	many juveniles

84	09/07/2002	Pelican	Roses-outdoor				negative	no juveniles
85	09/07/2002	Pelican	Roses-out door				negative	no juveniles
86	09/07/2002	Pelican	Acacia-				negative	no juveniles
87	09/07/2002	Pelican	Limonium				negative	few juveniles
88	09/07/2002	Pelican	Buplerium				negative	no juveniles
89	09/07/2002	Pelican	carrots				negative	no juveniles
90	09/07/2002	Pelican	Hse 10				negative	no juveniles
91	09/07/2002	Pelican	Hse 11				negative	few juveniles
92	09/07/2002	Pelican	Hse 13				negative	no juveniles
93	16/07/2002	Outgrowers-Mwea	Farm 37		Beans-Samantha		negative	many juveniles
94	16/07/2002	Outgrowers-Mwea	Farm 11				negative	no juveniles
95	16/07/2002	Outgrowers-Mwea	Farm 19		Beans-Samantha		negative	few juveniles
96	16/07/2002	Outgrowers-Mwea	Farm 19		Beans-Paulista		negative	no juveniles
97	16/07/2002	Outgrowers-Mwea	Farm 59				negative	no juveniles
98	16/07/2002	Outgrowers-Mwea	Farm 36				negative	no juveniles
99	16/07/2002	Outgrowers-Mwea	Farm 73		Beans-Paulista		negative	many juveniles
100	16/07/2002	Outgrowers-Mwea	Farm 63		Beans-Paulista		negative	many juveniles
101	16/07/2002	Outgrowers-Mwea	Farm 19		Tomatoes		negative	many juveniles
102	17/07/2002	Hornbill	G 11		Ploughed		negative	The block had been deep chiselled
103	17/07/2002	Amani	A 17		Carrot		negative	many samples collected to confirm
104	01/08/2002	Malachite	M 21				negative	few juveniles
105	02/08/2002	Malachite	M 8				negative	many juveniles

106	03/08/2002	Malachite	M 53				negative	no juveniles
107	04/08/2002	Pelican			C. Rosella		negative	many juveniles
108	04/08/2002	Malachite	M 28				negative	few juveniles
109	04/08/2002	Malachite	M 18				negative	few juveniles
110	04/08/2002	Malachite	M 27				negative	no juveniles
111	04/08/2002	Amani	A 6				negative	no juveniles
112	04/08/2002	Amani	Amani Trial site				negative	few juveniles
113	04/08/2002	Tacazze	U 40				negative	many juveniles
114	04/08/2002	Turacol	A 1				negative	no juveniles
115	05/08/2002	Turacol	A 2				negative	no juveniles
116	06/08/2002	Tacazze	U 53				negative	no juveniles
117	06/08/2002	Tacazze	U 54				negative	no juveniles
118	06/08/2002	Tacazze	U 53-grass				negative	no juveniles
119	06/08/2002	Tacazze	U 54-forest				negative	no juveniles
120	06/08/2002	Malachite	M 13				negative	few juveniles
121	06/08/2002	Malachite	M 37				negative	few juveniles
122	06/08/2002	Malachite	M 6				negative	few juveniles
123	06/08/2002	Amani	A 8		strawberry		negative	no juvenile
124	06/08/2002	Halycon-office			field insectary		negative	no juvenile
125	06/08/2002	Malachite	M 36		S/onion		negative	few juveniles
126	06/08/2002	Malachite	M 12		S/onion		negative	few juveniles
127	06/08/2002	Amani	A 6		groundnuts/kikuyu grass		negative	no juveniles
128	06/08/2002	Amani	A 7		trials site		negative	few juveniles
129	10/08/2002	Outgrowers-Mwea	Muriuki Ngure				negative	many juveniles
130	10/08/2002	Outgrowers-Mwea	Ornate Petals		Beans		negative	many juveniles
131	10/08/2002	Outgrowers-Mwea	E.Muthoni				negative	many juveniles

132	10/08/2002	Outgrowers-Mwea	Ornate Petals		Capsicum		negative	many juveniles
133	18/08/2002	Siraji	E 2		Carrots		negative	no juveniles
134	18/08/2002	Siraji	C 1		Carrots		negative	no juveniles
135	18/08/2002	Siraji	E 5		Carrots		negative	no juveniles
136	18/08/2002	Siraji	E 4		MT		negative	no juveniles
137	18/08/2002	Malachite	J 14		MT		negative	no juveniles
138	18/08/2002	Malachite	J 10		MT		negative	no juveniles
139	18/08/2002	Malachite	J 12		Peas		negative	no juveniles
140	18/08/2002	Malachite	J 14		Peas		negative	no juveniles
141	19/08/2002	Pelican	Prodn site		Broad beans		negative	no juveniles
142	19/08/2002	Pelican	Hse 6		Canation-VG yellow		negative	many juvenlies
143	19/08/2002	Pelican	Hse 19		Canation-VG yellow		negative	many juvenlies
144	**19/08/2002**	**Pelican**	**Hse 10**		**carnation - Autumn**		**positive**	**many juveniles few with spores-3 ,1 spore each.**
145	19/08/2002	Pelican	Hse 10		Carnation-Salmolytandem		negative	many juveniles
146	25/08/2002	Amani	L 16				negative	many juveniles
147	25/08/2002	Amani	L 18				negative	few juveniles
148	25/08/2002	Amani	L 22				negative	no juveniles
149	25/08/2002	Amani	L 21				negative	no juveniles
150	25/08/2002	Amani	L 16				negative	many juveniles
151	16/09/2002	Hornbill	G 9	S/snaps	Runnerbeans	6 wks.	negative	no juvenile
152	16/09/2002	Hornbill	G 11		Kales	5 wks.	negative	no juvenile
153	16/09/2002	Hornbill	H 9(L.S)	R/beans	Leeks	16 wks.	negative	no juvenile
154	16/09/2002	Hornbill	H 9(U.S)	R/beans	Leeks	16 wks.	negative	few juveniles.
155	16/09/2002	Hornbill	G 12	Carrots	No crop	N/A	negative	no juvenile
156	16/09/2002	Tacazze	U 20A	R/beans	Carrots	4 wks.	negative	no juvenile, crop too young
157	16/09/2002	Tacazze	U 65	R/beans	Kales	3 wks.	negative	few juveniles.

158	16/09/2002	Tacazze	U 37	R/beans	Peas	3 wks.	negative	no juvenile
159	17/09/2002	Flamingo	Hse 43	Roses Vrty	Rose Variety Kiss	-	negative	many juveniles.
160	17/09/2002	Flamingo	Hse G1B	Carnation Vrty	Rose Variety Jackpot	-	negative	many juveniles.
161	17/09/2002	Flamingo	Hse 13	Roses Vrty	Rose Variety Kiss	-	negative	few juveniles.
162	**17/09/2002**	**Flamingo**	**Hse 22**	**Roses Vrty**	**Rose Variety Golden gate**	**-**	**positive**	**1 juvenile 3 spores, 1 juvenile >5 spores, others 1 and 2 spores each**
163	17/09/2002	Flamingo	Hse 14	Roses Vrty	Rose Variety Europa		negative	few juveniles.
164	17/09/2002	Flamingo	Hse 19	Roses Vrty	Rose Variety Lambada		negative	many juveniles.
165	**17/09/2002**	**Flamingo**	**Hse 69**	**Carnation**	**Carnation Variety Dark Pink Barbara**		**few spores**	**many juveniles,1 with 2 spores, 2 with 1 spore each**
166	17/09/2002	Flamingo	Hse 25	Roses Vrty	Rose Variety Duette		negative	few juveniles
167	17/09/2002	Flamingo	Hse 30	Roses Vrty	Rose Variety Golden gate		negative	few juveniles.
168	**17/09/2002**	**Flamingo**	**Hse 25**	**Roses Vrty**	**Rose Variety Charming unique**		**few spore**	**2 nematodes each 1 spore.**
169	22/09/2002	Siraji	G 1	R/beans	Sugargem	21 wks.	negative	no juveniles
170	22/09/2002	Siraji	G 2	R/beans	Sugargem	21 wks.	negative	no juveniles
171	22/09/2002	Siraji	G 3	R/beans	Sugargem	21 wks.	negative	no juvenile
172	22/09/2002	Siraji	G 7	R/beans	Sugargem	21 wks.	negative	no juvenile
173	22/09/2002	Siraji	E 4	R/beans	Sugargem	17 wks.	negative	no juvenile
174	22/09/2002	Siraji	R11	R/beans	Sugarsnaps	19 wks	negative	no juvenile
175	22/09/2002	Malachite	M 12	S/onions	Carrots	10 wks.	negative	no juvenile

176	22/09/2002	Malachite	M 13	R/beans	Carrots	9 wks.	negative	no juvenile
177	22/09/2002	Malachite	J 16	R/beans	Sugarsnaps	10 wks.	negative	no juvenile
178	22/09/2002	Malachite	J 18	R/beans	Sugarsnaps	14 wks.	negative	no juvenile
179	24/09/2002	Amani	L 15	Peas	French beans	9 wks.	negative	no juvenile
180	24/09/2002	Amani	L 4	Peas	French beans	8 wks.	negative	no juvenile
181	24/09/2002	Amani	L 5	R/beans	French beans	8 wks.	negative	few juveniles
182	24/09/2002	Tacazze	U 19(L.S)	Peas	Carrots	10 wks.	negative	few juveniles
183	24/09/2002	Tacazze	U 19(U.S)	Peas	Carrots	10 wks.	negative	few juveniles
184	24/09/2002	Tacazze	U 19(M.S)	Peas	Carrots	10 wks.	negative	no juveniles
185	24/09/2002	Pelican	Hse 11	Carnation Vrty	Carnation Variety Rosella.		negative	many juveniles
186	24/09/2002	Pelican	Hse 10	Carnation Vrty	Carnation variety Autumn		negative	many juveniles
187	26/09/2002	Kenya Flower Council - Ruiru			Roses	KFC 1	negative	no juveniles
188	**03/10/2002**	**Flamingo**	**Hse 22**	**Roses Vrty**	**Rose Variety Golden gate**		**positive**	**two juvenile with one spore each**
189	03/10/2002	Flamingo	Hse 69	Carnation	Dark Pink Barbara		negative	one juvenile
190	03/10/2002	Flamingo	Hse 25	Roses Vrty	Rose Variety Charming unique		negative	many juveniles
191	03/10/2002	Flamingo	Hse 25	Roses Vrty	Rose Variety Duette		negative	few juveniles
192	05/10/2002	Tacazze	U 10	R/beans	Carrots	10 wks.	negative	few juveniles.
193	05/10/2002	Malachite	J 18	Oats	S/snaps	16 wks.	negative	no juveniles.
194	08/10/2002	Siraji	R 17	R/beans	S/snaps	17 wks.	negative	no juveniles

195	10/10/2002	Flamingo	Hse 22	Roses Vrty	Rose Variety Golden gate	X A	negative	few juveniles
196	10/10/2002	Flamingo	Hse 22	Roses Vrty	Rose Variety Golden gate	X B	negative	no juveniles
197	**10/10/2002**	**Flamingo**	**Hse 22**	**Roses Vrty**	**Rose Variety Golden gate**	**X C**	**negative**	**juveniles with hair like projections**
198	10/10/2002	Flamingo	Hse 22	Roses Vrty	Rose Variety Golden gate	Y 1	negative	planted with tomatoes
199	10/10/2002	Flamingo	Hse 22	Roses Vrty	Rose Variety Golden gate	Y 2	negative	planted with tomatoes
200	10/10/2002	Flamingo	Hse 22	Roses Vrty	Rose Variety Golden gate	Y 3	negative	planted with tomatoes
201	12/10/2002	Kenya Flower council			Roses roots		negative	few juveniles
202	15/10/2002	Kenya Flower council			Roses		negative	few juveniles
203	17/10/2002	Malachite	J 21		Sugarsnaps	16 wks	negative	few juveniles
204	17/10/2002	Malachite	M 36		Carrots	10 wks	negative	many juveniles
205	**18/10/2002**	**Flamingo**	**Hse 22**	**Roses Vrty**	**Rose Variety Golden gate**	**2 samples**	**positive**	**some juveniles with hair like projections on the cuticle**
206	18/10/2002	Flamingo	Hse 25	Roses Vrty	Rose variety Duette	2 samples	negative	few juveniles
207	18/10/2002	Flamingo	Hse 69	Carnation	Rose Variety Dark Pink Barbara	2 samples	negative	few juveniles
208	18/10/2002	Flamingo	Hse 25	Roses Vrty	Rose Variety Charming unique	2 samples	negative	many juveniles
209	19/11/2002	Siraji	F 6	R/beans	Empty		negative	no juveniles

210	19/11/2002	Siraji	R 18	R/beans	Empty		negative	no juveniles
211	19/11/2002	Siraji	R 12	R/beans	Empty		negative	no juveniles
212	19/11/2002	Siraji	R 19	Sugargem	Empty		negative	no juveniles
213	19/11/2002	Siraji	F 7	R/beans	Empty		negative	no juveniles
214	20/11/2002	Malachite	M 29	Carrots	Empty		negative	no juveniles
215	20/11/2002	Malachite	M 21	Peas	Carrots	11 wks	negative	few juveniles
216	20/11/2002	Malachite	J 20	Oats	S/snaps	16 wks.	negative	no juveniles
217	20/11/2002	Malachite	J 19	R/beans	S/snaps	16 wks	negative	many juveniles
218	20/11/2002	Malachite	J 22	Peas	S/snaps	16 wks	negative	no juveniles
219	20/11/2002	Malachite	J 19	Runner beans	S/snaps	16 wks	negative	many juveniles
220	20/11/2002	Malachite	M 29	Carrots	Empty		negative	no juveniles
221	20/11/2002	Malachite	J 29				negative	no juveniles
222	20/11/2002	Malachite	M 21	Peas	Carrots	11 wks	negative	very few juveniles
223	20/11/2002	Malachite	J 2				negative	many juveniles
224	20/11/2002	Malachite	J 22	Peas	S/snaps	16 wks	negative	no juveniles
225	29/11/2002	Tacazze	U36	Peas	carrots	10 wks	negative	few juveniles many rkn eggs.
226	29/11/2002	Tacazze	U 20	Carrots	empty		negative	few juveniles
227	06/12/2002	Naivasha	Hse C1	Carnation	Target		negative	no juveniles
228	06/12/2002	Naivasha	Hse 69	Carnation	Bosanka		negative	many juveniles
229	06/12/2002	Naivasha	Hse 10	Carnation			negative	few juveniles
230	06/12/2002	Naivasha	Hse 11	Carnation	Variety Cerise Rosella		negative	few juveniles
231	06/12/2002	Naivasha	C 5	Carnation	Bosanka		negative	no juveniles
232	06/12/2002	Naivasha	Hse G 2	Carnation	White Ashley		negative	few juveniles
233	**06/12/2002**	**Naivasha**	**Hse 69**	**Carnation**	**Variety Dark Pink Barbara**		**positive**	**3 juveniles one spore each, one juvenile three spore**
234	14/12/2002	Malachite	M9	Runner beans	empty		negative	few juveniles

235	14/12/2002	Malachite	M25	Runner beans	empty		negative	no juveniles
236	14/12/2002	Malachite	M7	Garden peas	empty		negative	few juveniles
237	14/12/2002	Malachite	M24	Garden peas	empty		negative	no juveniles
238	30/12/2002	Kari	B12	Carnations			negative	many juveniles
239	30/12/2002	Kari	B1	Carnations			negative	many juveniles
240	30/12/2002	Kari	A	Carnations			negative	very few juveniles
241	30/12/2002	Kari	B	Carnations			negative	no juveniles
242	30/12/2002	Kari	C	Carnations			negative	no juveniles
243	30/12/2002	Kari	D	Carnations			negative	no juveniles
244	30/12/2002	Kari	E	Carnations			negative	no juveniles
245	12/01/2003	Kari	sample 1	Carnations			negative	many juveniles
246	12/01/2003	Kari	sample 2	Carnations			negative	many juveniles
247	12/01/2003	Kari	sample 3	Carnations			negative	many juveniles
248	26/01/2003	Kari	Hse 13 A	Carnations	Cerise Rosella		negative	few juveniles
249	26/01/2003	Kari	Hse 6 B	Carnations	Peacloy Int.		negative	many juveniles
250	26/01/2003	Kari	Hse 22 B	Carnations	Cerise Rosella		negative	many juveniles
251	26/01/2003	Kari	Hse 4 A	Carnations	Ceasar		negative	no juveniles
252	26/01/2003	Kari	Hse No. 1	Carnations			negative	Very few juveniles house fumigated
253	26/01/2003	Kari	Hse 6 A	Carnations	Barbara		negative	few juveniles
254	30/01/2003		Green house 7		Guernsey Y.		negative	no juveniles
255	31/01/2003		Green house 10		Berry		negative	no juveniles
256	31/01/2003		Green house 9		Smart		negative	no juveniles
257	05/02/2003	Amani	Block 9	R/beans	Empty		negative	few juveniles
258	05/02/2003	Malachite	Block J 7	R/beans	Empty		negative	few juveniles
259	20/02/2003	Malachite	M 52	S/snaps	Empty		negative	few juveniles
260	26/02/2003	Flamingo	Hse 22-a				negative	very few juveniles

261	26/02/2003	Flamingo	Hse 22-b				negative	many juveniles
262	26/02/2003	Flamingo	Hse 22-c				negative	no juveniles
263	26/02/2003	Flamingo	Hse 22-d				negative	few juveniles
264	26/02/2003	Flamingo	Hse 22-e				negative	few juveniles
265	**26/02/2003**	**Flamingo**	**Hse 22-f**				**positive**	**few juveniles 2 juveniles with 1 spore each**
266	27/02/2003	Amani	B 2	R/beans			negative	no juveniles
267	06/03/2003	Malachite	J 33A	R/beans			negative	No juveniles
268	06/03/2003	Malachite	J 33B	R/beans			negative	No juveniles
269	09/03/2003	Malachite	M 31	Carrots	Leeks		negative	no juveniles
270	09/03/2003	Malachite	M 30	Carrots	R/beans	8 wks.	negative	no juveniles
271	10/03/2003	Tacazze	U 7	R/beans			negative	no juveniles
272	10/03/2003	Tacazze	U 44	Carrots	brocolli		negative	no juveniles
273	10/03/2003	Tacazze	U 28	Carrots	R/beans		negative	no juveniles
274	10/03/2003	Tacazze	U 19	Carrots	R/beans	10 wks.	negative	few juveniles
275	10/03/2003	Tacazze	U 45	Carrots	R/beans		negative	no juveniles
276	10/03/2003	Amani	A 17				negative	no juveniles
277	12/03/2003	Amani	B 10				negative	no juveniles
278	12/03/2003	Amani	L 25				negative	no juveniles
279	12/03/2003	Amani	L 6				negative	no juveniles
280	18/03/2003	Siraji	F 6	Peas	carnation		negative	no juveniles
281	18/03/2003	Siraji	F 4	Peas	carnation		negative	no juveniles
282	18/03/2003	Siraji	F 3	Peas	carnation		negative	no juveniles
283	18/03/2003	Siraji	F 7	Peas	carnation		negative	no juveniles
284	18/03/2003	Siraji	F 5	Peas	carnation		negative	no juveniles
285	18/03/2003	Siraji	F 8	Peas	carnation		negative	no juveniles
286	18/03/2003	Amani	B 11	R/beans	R/beans		negative	no juveniles
287	26/03/2003	Tacazze	U 4	Peas	Leeks		negative	few juveniles
288	26/03/2003	Tacazze	U 61	Peas	Carrots		negative	few juveniles
289	26/03/2003	Tacazze	U 29	Peas	Carrots		negative	few juveniles
290	07/04/2003	Siraji	B 1				negative	no juveniles
291	07/04/2003	Siraji	E 7				negative	no juveniles

292	19/04/2003	Tacazze	U 16	R/beans	Carrots		negative	few juveniles
293	30/04/2003	Amani	L 6	R/beans	Carrots		negative	no juveniles
294	02/05/2003	Amani	B 14	R/beans	Carrots		negative	no juveniles
295	07/05/2003	Malachite	M 16A/B	leeks	Carrots		negative	few juveniles
296	18/05/2003	Amani	A 11	R/beans	Carrots		negative	few juveniles
297	26/05/2003	Malachite	M 8	R/beans	Carrots		negative	few juveniles
298	26/05/2003	Malachite	J 13	R/beans	Carrots		negative	few juveniles
299	29/05/2003	Tacazze	U 37	R/beans	Carrots		negative	few juveniles
300	29/05/2003	Tacazze	U 24	R/beans	Peas		negative	few juveniles
301	10/06/2003	Tacazze	U 32	R/beans	Carrots		negative	no juveniles
302	10/06/2003	Tacazze	U 6	Peas	Carrots		negative	few juveniles
303	10/06/2003	Tacazze	U 7	Peas	Carrots		negative	few juveniles
304	10/06/2003	Tacazze	U 18	R/beans	Carrots		negative	few juveniles
305	13/06/2003	Tacazze	U 42	R/beans	Carrots		negative	few juveniles
306	13/06/2003	Tacazze	U 40	R/beans	Carrots		negative	few juveniles
307	13/06/2003	Tacazze	U 53 a	M/T	Carrots		negative	few juveniles
308	13/06/2003	Tacazze	U 53 a	M/T	Carrots		negative	few juveniles
309	13/06/2003	Amani	L 4	R/beans	Carrots		negative	no juveniles
310	13/06/2003	Amani	L 11				negative	few juveniles
311	13/06/2003	Amani	L 12				negative	few juveniles
312	13/06/2003	Amani	L 14				negative	few juveniles
313	13/06/2003	Amani	L 16				negative	few juveniles
314	13/06/2003	Amani	L 18				negative	few juveniles
315	15/06/2003	Tacazze	U 43	peas	Carrots		negative	few juveniles
316	15/06/2003	Hornbill	G 3	peas	Carrots		negative	few juveniles
317	15/06/2003	Malachite	J 17	R/beans	Carrots		negative	few juveniles
318	18/06/2003	Tacazze	U 39	R/beans	Carrots		negative	no juveniles
319	18/06/2003	Tacazze	U 60	peas	Carrots		negative	few juveniles
320	19/06/2003	Tacazze	U 14	R/beans	Carrots		negative	few juveniles
321	19/06/2003	Malachite	M 51	Peas	Carrots		negative	no juveniles
322	19/06/2003	Malachite	M 52	Peas	Carrots		negative	few juveniles
323	19/06/2003	Malachite	M 17	R/beans	Carrots		negative	few juveniles

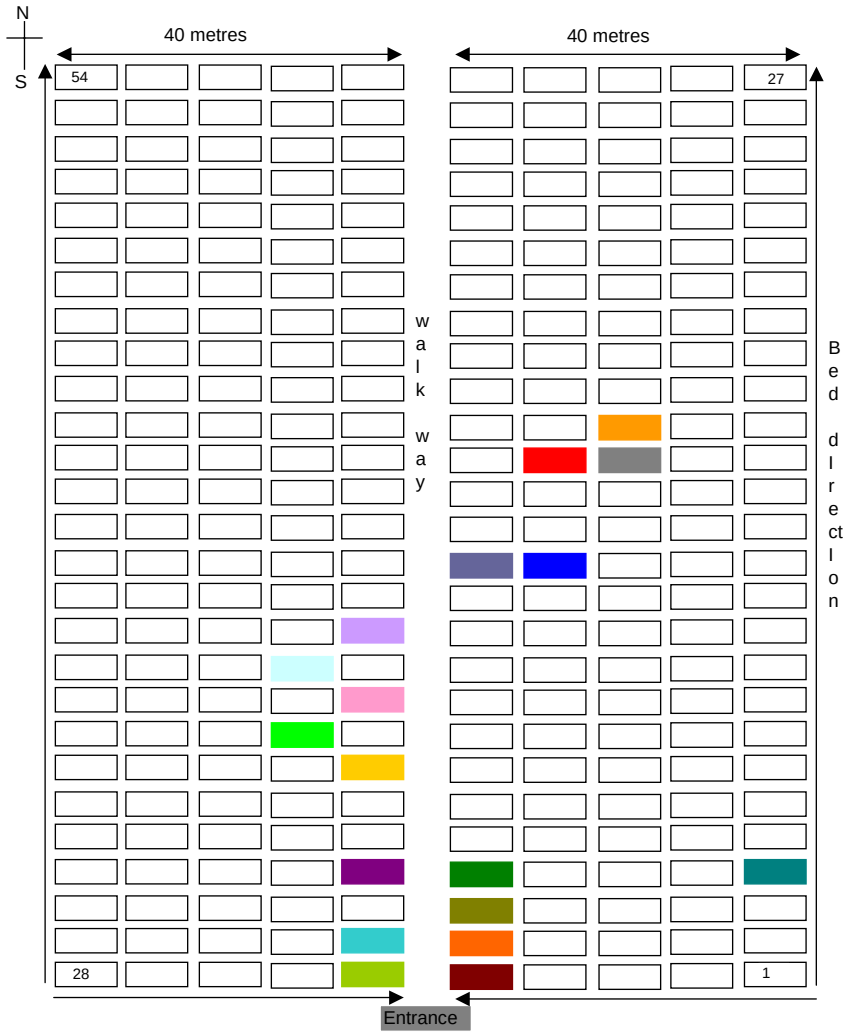
324	19/06/2003	Malachite	M 28	R/beans	Carrots		negative	few juveniles
325	20/06/2003	Amani	L 3	R/beans	Carrots		negative	few juveniles
326	20/06/2003	Amani	L 23	Peas	Carrots		negative	few juveniles
327	20/06/2003	Amani	L 5	R/beans	Carrots		negative	few juveniles
328	20/06/2003	Amani	B 4	R/beans	Carrots		negative	few juveniles
329	08/07/2003	Tacazze	U 10	R/beans	Carrots		negative	few juveniles
330	08/07/2003	Tacazze	U 58	R/beans	Carrots		negative	no juveniles
331	06/08/2003	Tacazze	U 26	R/beans	Carrots		negative	few juveniles

Appendix 2: Strategic sampling of G 11 and H 22 blocks.

Lab Id	Date Of Sampling	Farm Id	Block Id	Sample Id	Crop On Ground	Pp Status	Comments
1	12/10/2002	Flamingo	H22	Y1	Rose-Duette	negative	no juveniles
2	12/10/2002	Flamingo	H22	Y2	Rose-Duette	negative	few juveniles
3	12/10/2002	Flamingo	H22	Y3	Rose-Duette	negative	no juveniles
4	12/10/2002	Flamingo	H22	XA	Rose-Duette	negative	few juveniles
5	12/10/2002	Flamingo	H22	XB	Rose-Duette	negative	no juveniles
6	12/10/2002	Flamingo	H22	XC	Rose-Duette	negative	few juveniles with hair like projections from cuticle
7	27/02/2003	Flamingo	H22	6a	Rose-Duette	negative	few juveniles
8	27/02/2003	Flamingo	H22	6b	Rose-Duette	**positive**	few juveniles
9	27/02/2003	Flamingo	H22	5a	Rose-Duette	negative	few juveniles
10	27/02/2003	Flamingo	H22	5b	Rose-Duette	negative	no juveniles
11	27/02/2003	Flamingo	H22	4a	Rose-Duette	negative	few juveniles
12	27/02/2003	Flamingo	H22	4b	Rose-Duette	negative	no juveniles
13	27/02/2003	Flamingo	H22	bed 1 stn 1	Rose-Duette	negative	very few juveniles
14	27/02/2003	Flamingo	H22	bed 1 stn 2	Rose-Duette	negative	many juveniles
15	27/02/2003	Flamingo	H22	bed 1 stn 3	Rose-Duette	negative	no juveniles
16	15/07/2003	Hornbill	G11	LS rep 4	Carrot	negative	no juveniles
17	15/07/2003	Hornbill	G11	LS rep 3	Carrot	negative	very few juveniles
18	15/07/2003	Hornbill	G11	LS rep 1	Carrot	negative	no juveniles
19	15/07/2003	Hornbill	G11	LS rep 2	Carrot	negative	many juveniles
20	15/07/2003	Hornbill	G11	LS rep 5	Carrot	negative	no juveniles
21	15/07/2003	Hornbill	G11	MS rep 2	Carrot	negative	very few juveniles
22	15/07/2003	Hornbill	G11	MS rep 5	Carrot	negative	very few juveniles
23	15/07/2003	Hornbill	G11	MS rep 4	Carrot	negative	few juveniles
24	15/07/2003	Hornbill	G11	MS rep 1	Carrot	negative	very few juveniles
25	15/07/2003	Hornbill	G11	MS rep 3	Carrot	negative	very few juveniles
26	15/07/2003	Hornbill	G11	US rep 2	Carrot	negative	no juveniles
27	15/07/2003	Hornbill	G11	US rep 4	Carrot	negative	no juveniles
28	15/07/2003	Hornbill	G11	US rep 1	Carrot	negative	no juveniles

Appendix 3: House 22 Sampling plan

Flamingo Hse 22 Sampling plan



Direction of sampling

Key
Bed width 50cm
Total bed length 40 metres
Inter row spacing 40cm
Sampling unit 5 x 5, Total number of samples screened = 270

Bed colour	Spores/Juvenile counted	Comments
	2, 2, 1, 8, 6	
	3, 2,	<10 J2/2mL
	1	Many J2 present
	1	Very few J2
	1	Very few J2
	1, 1, 1	
	1	
	1	Very few J2, less than 5/2mL
	2	

Appendix 4: Dry weight of root powder per plant

Sample ref	Sample no	Sample weight (gm)
51 - 91	1	3.57
51 - 91	2	4.603
51 - 91	3	4.534
51 - 91	4	5.8
51 - 91	5	2.979
51 - 91	6	2.51
51 - 91	7	2.03
51 - 91	8	1.77
51 - 91	9	1.33
51 - 91	10	0.85
51 - 91	11	1.167
1 - 29	1	2.204
1 - 29	2	2.615
1 - 29	3	1.207
1 - 29	4	2.697
1 - 29	5	1.877
1 - 29	6	2.259
1 - 29	7	1.517
1 - 29	8	1.817
1 - 29	9	1.779
1 - 29	10	2.101
92 - 101	1	2.61
92 - 101	2	3.095
92 - 101	3	1.112
92 - 101	4	0.985
92 - 101	5	1.931
92 - 101	6	1.243
92 - 101	7	1.544
92 - 101	8	0.846
92 - 101	9	1.406
92 - 101	10	0
Mean		**2.13**