The effects of *Meloidogyne javanica* on two sweetpotato cultivars

PW17001 Final report Appendix 20 Integrated pest management of nematodes in sweetpotato

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The Department of Agriculture and Fisheries proudly acknowledges all First Nations peoples (Aboriginal peoples and Torres Strait Islanders) and the Traditional Owners and Custodians of the country on which we live and work. We acknowledge their continuing connection to land, waters and culture and commit to ongoing reconciliation. We pay our respect to their Elders past, present and emerging.

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Summary

To determine the effects of RKN species M. javanica infection on storage roots, a long term pot trial was conducted in 2022 at the Bundaberg Research facility plant house. A report on the trial can be found in Appendix 17. The trial was designed to investigate the damage to skin quality caused by Root-knot nematode (Meloidogyne javanica) on the storage roots of two sweetpotato cultivars Beauregard and Bellevue.

Outputs

Results indicated that the higher the *M.javannica* population in the soil, the lower the number of premium roots and the higher the percentage of non-marketable roots. Data indicates that the Beauregard cultivar is more susceptible to *M. javanica* infection than Bellevue, with mean *M. javanica* counts more than 3 times that of the Bellevue plants. There also appears to be some evidence that Bellevue is more resistant to barnacles than Beauregard. The data from this trial supports previous studies suggesting that Beauregard is highly susceptible to *M. javanica* and Bellevue moderately susceptible (Cobon et al., 2021).

Infection with *M. javanica* reduced both the number of roots produced and the overall weight of roots and was associated with reduced marketability, ultimately negatively impacting crop value.

Outcomes /Take home message/key findings.

The mean M. Javanica count in pots from Beauregard plants was more than 3 times that of the pots containing Bellevue plants, indicating that the Beauregard variety is more susceptible to RKN infection.

The higher the *M.javannica* population in the soil, the lower the number of premium roots and the higher the percentage of non-marketable roots.

Infection with *M. javanica* reduced both the number of roots produced and the overall weight of roots and was associated with reduced marketability, ultimately negatively impacting crop value.

The effects of *Meloidogyne javanica* on two sweetpotato cultivars

Introduction

Root-knot nematode (RKN), *Meloidogyne* spp. are a species of great importance to the sweetpotato industry in Australia. Root-knot nematode is estimated to cost the industry $20 million per year (Cobon et al., 2021). Stirling (2021) states that nematode damage often results in 5–20% of marketable sweetpotato being discarded, occasionally reaching as high as 75% in some cases. *M. javanica* is one of the four *Meloidogyne* species associated with sweetpotato in Australia. It can be found throughout southern Queensland and northern coastal New South Wales and is the most widespread RKN species in areas where sweetpotatoes are grown (Stirling et al., 2020).

The above-ground symptoms of *Meloidogyne* spp. can sometimes be seen, but not always, in the form of stunting, wilting, and yellowing (Stirling, 2016; Quesada-Ocampo, 2018; Grabau & Noling, 2021). Below-ground, infested feeder roots display a distinctive galling which can range from 1-2mm to the size of marbles (Stirling 2016). Quesada-Ocampo (2018) reported that cracking of the storage roots maybe another below-ground symptom. Grabau & Noling (2021) state that storage root cracking is infrequent in modern cultivars. Smith et al (2017) describes roots damaged by root-knot nematode as being rough textured, malformed, and cracked. On the Beauregard variety, the nematode can cause pimples or raised areas in which root-knot nematode can sometimes be found (Smith et al., 2017). Thomas (1982) found malformed, deeply indented roots with rough scabs that are linked with newly developed sprouts that have been attacked and destroyed. Hajihassani (2022) describes symptoms as veiny appearance, surface cracking, and bumpy yellow to brown-coloured specks.

This pot trial was developed to assess the effects of *M. javanica* on two Australian grown sweetpotato cultivars, Beauregard and Bellevue. Both cultivars are known hosts, with Beauregard found to be highly susceptible to *M. javanica* and Bellevue moderately susceptible (Cobon et al 2021). Anecdotal evidence from sweetpotato growers suggests that Bellevue planted into blocks with populations of M. javanica rarely display symptoms of RKN infection Dennien pers. Comm., 2021.

Methodology

Experimental Set Up

The pot trial experiment was a randomised design conducted in an insect proof plant house. Pots were filled with pasteurised field soil. Two sweetpotato cultivars (Bellevue and Beauregard) were each subjected to two treatments, a nematode treatment (pots inoculated with a known number of M. javanica eggs), and a control treatment (no inoculation). Both treatments consisted of six replicates (Table 1). Twelve cuttings of each cultivar were grown in individual 27L pots giving a total of 24 pots. Plants were grown using best practice agronomy for 132 days, the approximate duration of a commercial crop.

Table 1 Pot trial design

Cultivar	Number of plants	Treatment
Beauregard	12	6 plants inoculated with *M. javanica*
Beauregard	12	6 plants inoculated with *M. javanica*
Bellevue	12	6 control plants not inoculated
Bellevue	12	6 control plants not inoculated

Sweetpotato vines were planted on the 27th of September 2022 (Image 3a & 3b). The inoculation of *M. javanica* occurred 16 days later, once the vines had established a thriving root system ensuring delivery of the nematodes onto plants.

Image 1 a) Beauregard (back) and Bellevue (front) vine; b) vine is laid in the furrow with all 4 nodes buried; c) inoculum mix evenly distributed into the furrows.

Inoculation was delivered by applying a bag of nematode infested sand and root mixture into furrows dug 5cm deep either side of the vine (Fig. 3c). Each bag consisted of 100g of infested roots mixed with 200mL of Queensland DAF nematology sand mix. The approximate root-knot egg count being delivered to each pot was 295,200 eggs/pot (10,933 eggs per litre of soil).

The trial was harvested on the 6th February 2023 at 132 days after planting. The canopy biomass was removed before carefully excavating the roots of each pot. The roots were then carefully hand washed to remove dirt prior to assessment. A representative soil sample of approximately 500g from each pot was collected and sent for extraction and quantification of nematodes.

Assessment and Measurements

Roots harvested from each pot were individually inspected for damage according to sweetpotato nematode assessment protocols. Individual root weight, length, and diameter were recorded, as was an overall weight of fibrous roots. Each storage root was assessed for damage severity and size graded using industry standards to determine first grade, second grade or non-marketable.

Data collection:

1. Quantitative measurements using balance and calipers.
2. Qualitative measurements:
    - Damage was rated using the proportion of skin surface area affected:
    - Low: 0 – 33% of the sweetpotato surface area
    - Medium: 34 – 66% of the sweetpotato surface area
    - High: 67 – 100% of the sweetpotato surface area
3. Presence / Absence of listed defects was also recorded.

Data analysis

Total and mean root weight, length and diameter, and total fibrous root weight were analysed using analysis of variance (ANOVA). The proportion of roots with the different types of damage was analysed using a generalised linear model (GLM). The number of roots in each pot was analysed using a Poisson GLM with a log link function. Analysis results were deemed significant at the 0.05 level. Where a significant effect was found, the 95% least significant difference (lsd) was used to make pairwise comparisons.

Results

Raised Pimples

Raised pimples were observed on storage roots in both treatments and both cultivars during assessment. Analysis of sweetpotato roots with raised pimples found that the nematode inoculated pots had a significantly higher prevalence of raised pimples compared to the control pots (Fig. 1). There was a high incidence of raised pimples in pots 12 and 15, which were treated pots. Five plants with a medium damage rating had been inoculated. Raised pimples were found only in low numbers in some control pots. RKN were found to have contaminated one of these control pots. Since the raised pimples were assessed in control plants where RKN were absent, the raised pimples on control plants may have been shoots in the early stage of formation. Another explanation could be that shoots will form a raised pimple and RKN may take advantage of the fresh vulnerable shoot. This could explain why RKN are found in some raised pimples and not all.

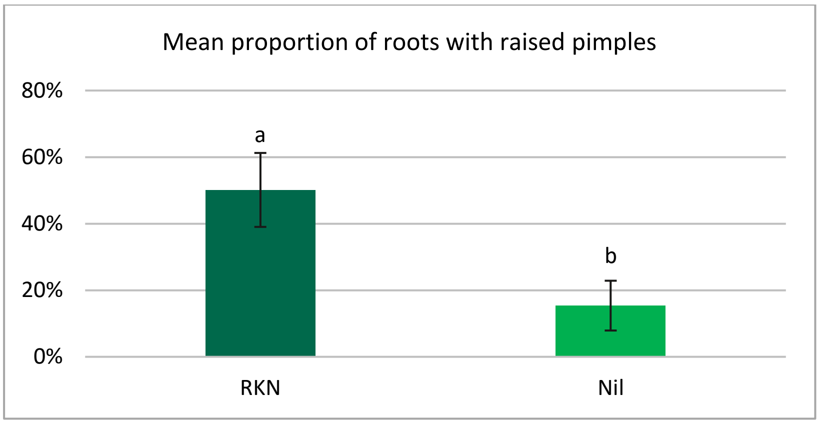

Figure 1 Mean proportion of roots with raised pimples.

Black Pimples

There was a significantly higher proportion of Black pimples on roots form the inoculated pots than the uninoculated pots of both Beauregard and Bellevue varieties (Table 2). Of all pots where RKN were detected, only three were found to have an absence of black pimples during the assessment. These three pots had the lowest RKN counts at 5, 48 and 108 RKN / 200g soil. The lowest RKN count with an incidence of black pimples was 135 RKN/ 200g soil. Black pimples were found in high incidences in 4 pots; of those, the lowest count was 321 RKN / 200g soil.

Table 2 Mean proportion of Beauregard and Bellevue roots with black pimples.

Black Pimple Mean Proportion		
Treatment	Mean	se
RKN	0.4615 a	0.06791
Nil	0.0000 b	0.00019
	95% lsd = 0.1457	

Barnacles

Roots with barnacle defects were found in significantly higher proportions in the Beauregard variety inoculated with RKN (Fig. 2). All Beauregard roots inoculated with nematodes, except one, displayed barnacles.. High incidences of the defect (four roots all with a high incidence of barnacles) were found in the nematode inoculated Bellevue pot 8, which had a RKN count of 7,984 / 200g soil. No barnacles were found on uninoculated Bellevue roots.

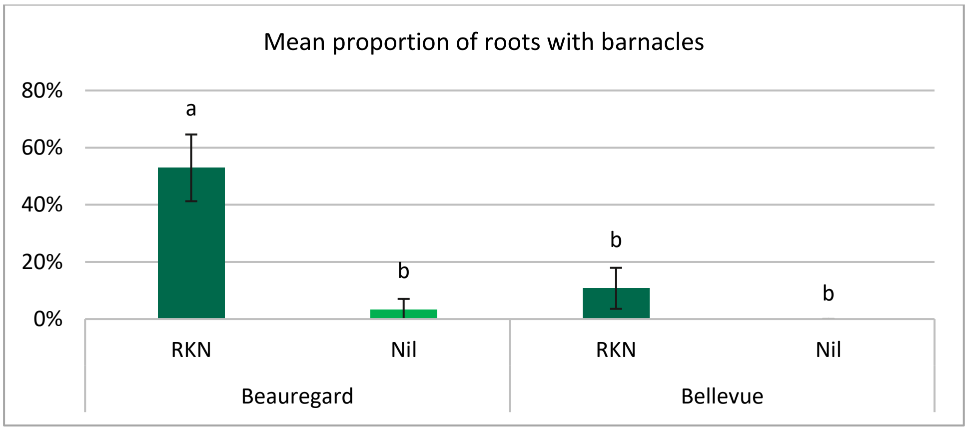

Figure 2 Mean proportion of roots with barnacles.

Darkened Lateral Root Scars

Darkened lateral root scars (DLRS) were found to be significantly higher on roots of Beauregard plants inoculated with nematodes (Fig. 3). Roots produced by uninoculated Beauregard plants were similar in DLRS incidence as the inoculated Bellevue roots. DLRS were found in all pots with the exception of five uninoculated pots.

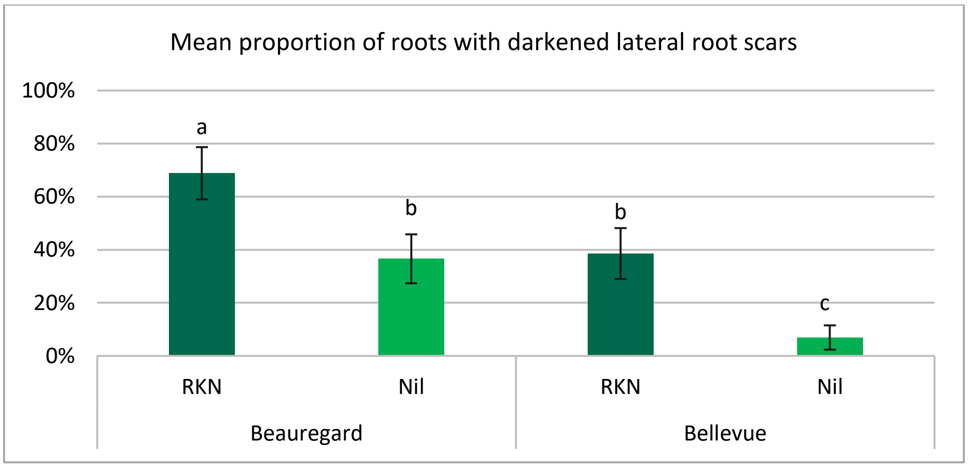

Figure 3 Mean proportion of roots with DLRS.

Elongated Lenticels

Significant differences were only found in roots that had a medium incidence of elongated lenticels (Fig. 4). Roots form inoculated Beauregard plants had a significantly higher medium rated incidence of elongated lenticels than both of the uninoculated varieties. Elongated lenticels were only found in low quantities on uninoculated Bellevue roots. Roots from twelve of the 20 plants exhibiting elongated lenticels were recorded at low severity.

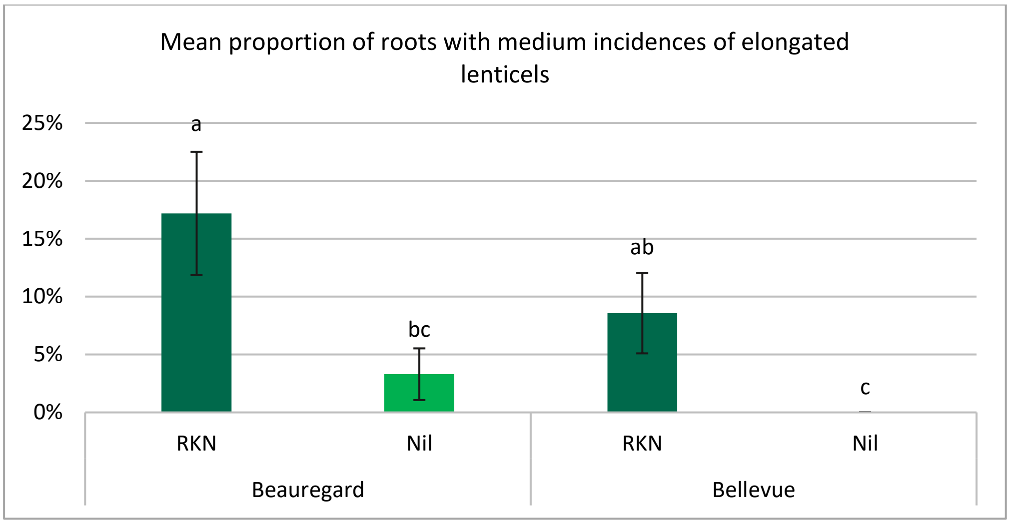

Figure 4 Mean proportion of roots with medium incidences of elongated lenticels.

Marketability

The Bellevue uninoculated plantswere found to produce the highest proportion of premium marketable first grade roots (Fig. 5). The inoculated Bellevue plants produced a significantly higher proportion of marketable first roots than both the inoculated and uninoculated treatments of Beauregard. The innoculated Beauregard did not produce any premium roots in this trial. This is a cultivar effect with Bellevue being a superior, higher yielding cultivar.

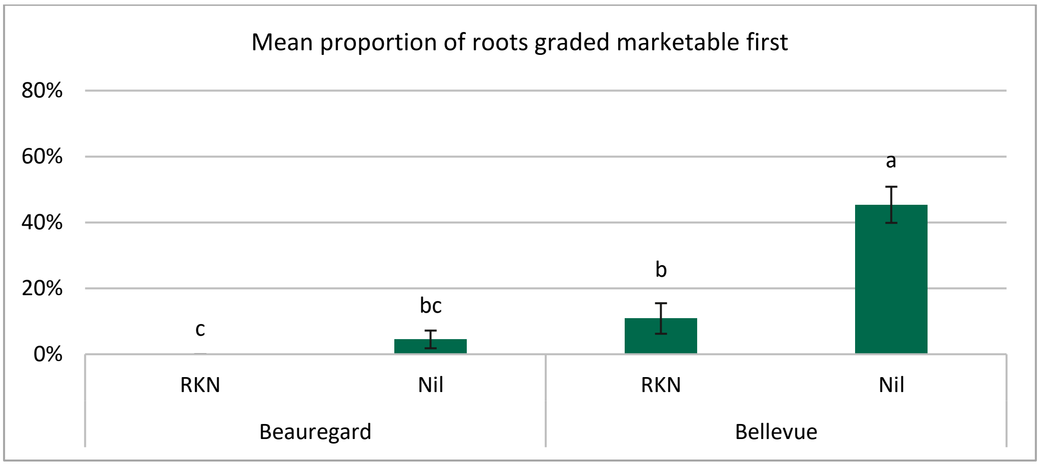

Figure 5 Mean proportion of roots graded marketable first.

The highest proportion of non-marketable roots were recorded in the inoculated Beauregard treatment, which was significantly higher than both Bellevue treatments (Fig. 6). Inoculated Bellevue roots were found to be non-marketable in higher proportions than the uninoculated Bellevue.

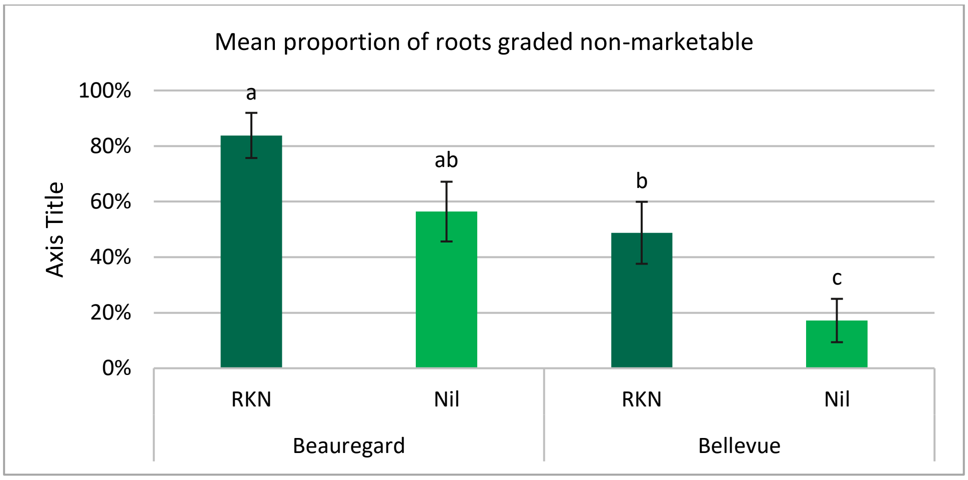

Figure 6 Mean proportion of roots graded non-marketable.

Discussion

The mean M. Javanica count in pots from Beauregard plants was more than 3 times that of the pots containing Bellevue plants. The uninoculated or Nil treatment Bellevue plants produced a significantly higher mean proportion of marketable first grade roots than the M. javanica inoculated plants. This was significantly higher than both the uninoculated Beauregard (did not produce any premium roots) and inoculated Beauregard plants. Inoculated Beauregard plants produced a significantly higher mean proportion of non- marketable roots and this was significantly higher than uninoculated Bellevue plants. Both Beauregard and Bellevue inoculated plants had a lower mean fibrous root weight than the uninoculated Beauregard and Bellevue plants. Across both cultivars overall, plants in the nil treatment (uninoculated plants) had a significantly higher mean root count than the nematode treatment (M. javanica inoculated plants).

A number of defects were found to occur on both inoculated and uninoculated roots suggesting that factors other than nematode infection were involved in the development of some skin defects whereas some skin defects were increased significantly in the inoculated pots indicating that the presence of M. javanica could intensify these defects. Plants of Beauregard and Bellevue inoculated with M. javanica produced a higher mean proportion of roots with black pimples than the uninoculated plants which did not display any black pimples.

Occurrences of DLSRs were assessed on a high, medium and low scale. The mean proportion of roots with medium rated DLSRs was significantly higher in roots produced by inoculated Beauregard plants compared to all other treatment combinations.

An analysis of relationships between pot soil counts of M. javanica, root characteristics and presence or absence of skin defects using Spearman's rank correlation coefficient identified the following significant correlations:

- As the M. javanica count increased, the number of roots produced decreased.
- As the M. javanica count increased, the mean root weight decreased.
- As the M. javanica count increased, the percentage of roots with a low rating of black pimple appears to have increased. No roots had a black pimple rating of low when the RKN count was 108 or less. Black pimple at a low rating was observed when the RKN count reached 135.
- As the M. javanica count increased, the the percentage of first grade roots produced by plants decreased.
- As the M. javanica count increased, the percentage of reject grade roots appears to have increased.

Results indicated that the higher the *M.javannica* population in the soil, the lower the number of premium roots and the higher the percentage of non-marketable roots. Data indicates that the Beauregard cultivar is more susceptible to *M. javanica* infection than Bellevue, with mean *M. javanica* counts more than 3 times that of the Bellevue plants. There also appears to be some evidence that

Bellevue is more resistant to barnacles than Beauregard. The data from this trial supports previous studies suggesting that Beauregard is highly susceptible to *M. javanica* and Bellevue moderately susceptible (Cobon et al., 2021).

Infection with *M. javanica* reduced both the number of roots produced and the overall weight of roots and was associated with reduced marketability, ultimately negatively impacting crop value.

Conclusion

The root-knot nematode *M. javanica* negatively impacts the commercial sweetpotato varieties Beauregard and Bellevue. RKN infection reduced both the number of roots produced and the overall weight of roots. *M. javanica* infection was also associated with reduced marketability, ultimately negatively impacting crop value. *M. javanica* enhanced the skin defects as well as causing defects such as black pimple or barnacles. The negative impact of this pest on a sweetpotato crop is severe enough to warrant the use of best practices in the management of this nematode.

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