CASE STUDY

SEPTEMBER 2020

SoilWealth NURTURING CROPS

Integrated Crop Protection PROTECTING CROPS

EFFECT OF A COAL-BASED SOIL AMENDMENT ON CARROTS GROWN IN SANDY SOIL

This case study reflects the results of a large-scale, on-farm, soil amendment demonstration trial, conducted by Center West Export (CWE) in the Gingin area, about 150 km north of Perth, Western Australia. The trial was conducted in carrot crops grown in a sandy soil typical for the region. A stabilised, nutrient-enriched, coal-based and pelletised soil amendment (hereafter referred to as Novihum) was incorporated once into the soil prior to planting. It was assessed for its potential to improve soil health and marketable yield, especially of Grade 1 carrots, over a 12-month period.

KEY FINDINGS

Application of Novihum at a rate of 1,235 kg/ha (500 kg/acre) influenced the following variables (average of two large scale plots):

- **Organic matter levels:** Novihum improved organic matter levels in the soil, compared to the control, after the first crop.
- **Soilborne diseases:** Novihum had a mixed effect on soilborne pathogen inoculum – noteworthy was the suppression of *Sclerotinia sclerotiorum* inoculum levels. The demo trial, however, could not establish a relationship between soilborne pathogen inoculum levels and marketable yield.
- **Yield:** Novihum increased marketable yield by 12% compared to the untreated control. This was calculated on the average of two years of data.

Conversely, the lower Novihum rate of 665 kg/ha (269 kg/acre) did not produce any improvement compared to the untreated control, except for soilborne pathogen inoculum reduction, to some extent. In both years, the crop from this treatment produced an even higher volume of waste carrots than the untreated control and the higher rate Novihum application. Currently, this result cannot be explained by the location of the plots (soil differences) or any crop management differences (irrigation, nutrition).

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RECOMMENDATIONS

Effects of applying the Novihum soil amendment need to be followed up over multiple years. Additionally, a range of variables need to be monitored. Several of these were not monitored in this on-farm demonstration trial.

We will continue to observe the trial area to assess longer term effects of Novihum on carrot crops, focusing on:

- Finding out when the product would have to be reapplied,
- Assessing the effect on soilborne diseases, and
- Finding out why the lower rate did not outperform the control treatment.

We will also assess overall economic benefits (i.e., benefits outweighing the costs, effect of different application rates, comparing Novihum with other organic amendments).

THE FARM AND TRIAL SET UP

The sandy soils of the farm in this trial are prone to decline in soil structure and loss of organic matter to levels below 1%, as well as loss of beneficial soil biology combined with an increase in soilborne disease levels. Using a quality soil amendment has been identified as one option to address these soil constraints. Fresh organic matter, such as manure, could not be used at the time for this purpose in the Gingin area due to the perceived risk of providing a breeding substrate for stable flies, which distress livestock. Also, current food safety requirements mean that any form of fresh manure cannot be applied just before planting a carrot crop. Additionally, organic soil amendments must be of a quality that can be repeatedly produced and easily applied and incorporated.

CWE provided a 4.73 ha (11.7 acre) trial area under solid set irrigation and cropped the trial area with carrots twice within a 12-month period (planting on 3 May 2018 and 2 March 2019, respectively). The German-based manufacturer Novihum Technologies GmbH provided the soil amendment for the trial. Novihum was broadcast and incorporated to 30 cm depth on 2 May 2018 at two rates – 665 kg/ha (269 kg/acre) and 1,235 kg/ha (500 kg/acre) – in a replicated strip trial set up with 0.53 ha (1.3 acre) plots for the different treatments. Each plot consisted of one bed of 1.2 m width planted with three double rows of carrots.

The main trial objectives were:

- **Maintaining organic carbon levels** in the intensively-cropped sandy soil
- **Achieving suppression of soilborne diseases,** especially cavity spot mainly caused by *Pythium sulcatum*
- **Increasing crop yield and quality.**

Soil and crop data were collected to establish the effect of Novihum through conventional soil fertility analysis (ExpressSoil – preplant 2 May 2018 and postharvest 23 October 2018), soilborne pathogen DNA analysis (SARDI Predicta testing[1] – preplant 2 May 2018 and postharvest 23 October 2018) and postharvest commercial grading by CWE (5 September 2018 and 9 July 2019).

[1] Michael Rettke, SARDI; Sampling for SARDI Soil DNA pathogen testing for vegetable crops

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ORGANIC MATTER LEVELS

While most of the general agronomic ratings remained the same (data not shown), organic matter levels may have improved due to Novihum input at the highest rate: The percentage organic matter increased from 0.30% to 0.85% (Table 1). By contrast, no difference was found between the untreated control and the low rate Novihum application. A positive effect on soil carbon would need confirmation given the data comes from one commercial demonstration trial. Also, 0.85% organic matter is still not within the optimum range for the soil type.

SUPPRESSION OF SOILBORNE PATHOGENS

Table 2 shows the results for the SARDI Predicta test both for preplant and postharvest sampling in 2018. A comparison between preplant and postharvest levels of pathogen DNA showed that levels of the following identified pathogens built up during the crop:

- *Rhizoctonia solani* anastomosis group 2.1 and 4, likely to cause crown rot and cavity spot-like symptoms in carrots
- *Pythium sulcatum,* which is the main pathogen causing cavity spot (Figure 1) in warm regions of Australia, and other detected *Pythium* species, the main cause for 'damping off' of young plants.

Another identified pathogen, *Sclerotinia sclerotiorum,* affecting the base of the leaves, was not tested preplanting as the test was still under development. However, the postharvest testing showed lower inoculum levels for Novihum treatments compared to the untreated control.

Figure 1. Cavity spot-induced, irregularly shaped lesions across mature carrot tap roots (Picture by Ausveg Vic)

At this stage, it is not known what level of pathogen inoculum found poses a commercial risk to carrot crops. Research so far has focused on identifying threshold levels of inoculum rather than identifying conditions (e.g. temperature, soil moisture, soil nutrient levels, pressure of other diseases or pests) that cause diseases to develop in different commercial production systems. Therefore, the effect of Novihum on soilborne disease development requires further investigation in replicated trials with monitoring of both biotic and abiotic variables.

CROP YIELD AND QUALITY

In 2018 and 2019, the high rate Novihum treatment produced the highest total yield and marketable yield (pack-out), with a pack-out reported 12% higher on average than the untreated control (see Figure 2). Furthermore, quality Grade 1 carrots' yield (Small to

Soil test detail	Recommended range	Preplant test results	Postharvest test results by treatment		
			Novihum 1,235 kg/ha	Novihum 665 kg/ha	Untreated control
Organic matter (%)	2.00	0.30	0.85	0.45	0.45
Total C (%)	1.00	0.19	0.58	0.32	0.28
Total N (%)		0.04	0.04	0.03	0.03
C/N Ratio	<30	4.58	14.5	10.8	11.7

Table 1. Soil fertility test results for preplant and postharvest soil sampling on 30 cm depth (samples taken in 2018).

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Medium #1 and Medium #1 combined, see Figure 2) was highest in the 1,235 kg/ha Novihum treatment in both years. Since Grade 1 carrots usually fetch double the price of quality Grade 2 carrots, carrots from the 1,235 kg/ha Novihum treatment would have received the highest return.

Conversely, the 665 kg/ha Novihum treatment slightly underperformed in both years, showing a pack-out 12% lower on average than the untreated control. Hence, optimum rate and cost-benefit analysis for Novihum applications need to be investigated further and customised for commercial production.

The inoculum levels of *Pythium*, *Rhizoctonia* and *Sclerotinia* detected (Table 2) could not be associated with any negative effect on marketable yield and quality.

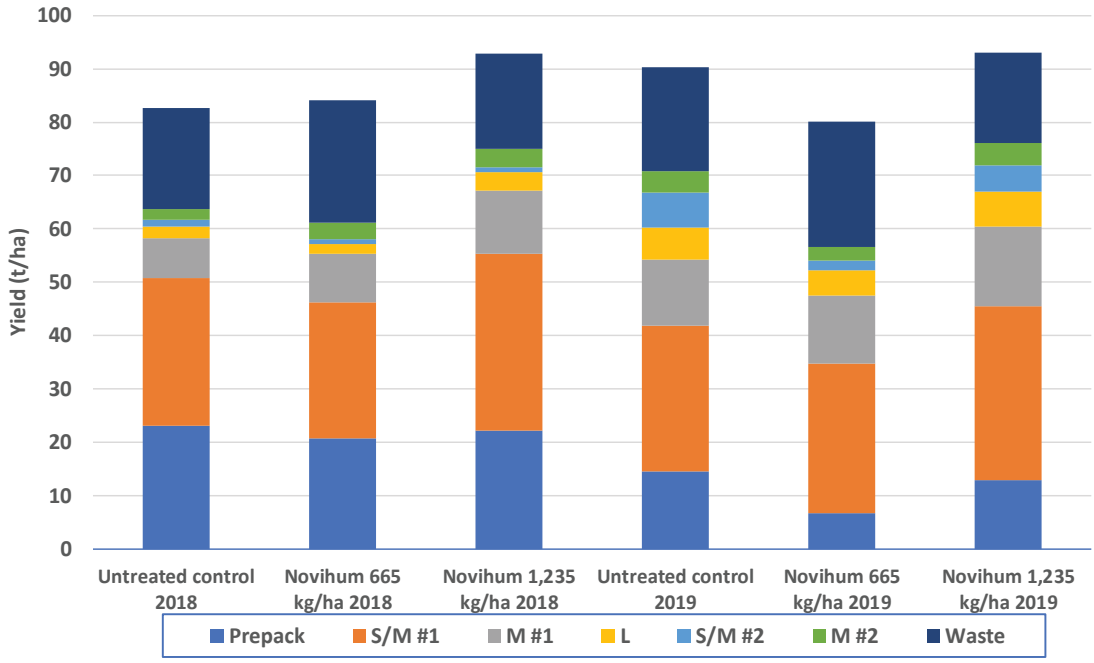

Figure 2. Commercial harvest grading (t/ha) for 2018 and 2019 carrot cropping (Prepack = small Grade 1 carrots packed in 1 kg bags; S/M #1 = small to medium length carrots of Quality 1, usually packed in 20 kg cartons; M #1 = medium size carrots of Quality 1, usually packed in 20 kg cartons; L = large size carrots, usually packed in 20 kg bags; S/M #2 = small to medium length carrots of Quality 2, usually packed in 20 kg cartons; M #2 = medium size carrots of Quality 2, usually packed in 20 kg cartons; Waste = carrots that could not be sold due to defects (mechanical, disease)). Pack-out = Prepack + S/M #1 + M #1 + L + S/M #2 + M #2.

AVERAGES	*Rhizoctonia solani* AG 2.1 (pg DNA/g)	*Rhizoctonia solani* AG 4 (pg DNA/g)	*Pythium sulcatum* (kDNA copies/g)	*Pythium clade* (pg DNA/g)	*Pythium clade* (pg DNA/g)	*Sclerotinia sclerotiorum* (kDNA copies/g)
Preplant levels	0	158	1	2	13	not tested
Untreated control	48	857	27	9	29	1,934
Novihum 665 kg/ha	5	415	23	5	22	23
Novihum 1,235 kg/ha	13	1,779	34	6	26	0

Table 2. Predicta soilborne pathogen DNA test results for 2018 sampling (average values). Differences in the reported units relate to the stage of development of the Predicta test. Results for a test in development are reported as kDNA copies/g sample, while results for established tests are reported as pg DNA/g sample.