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Project title: Koi carp product trial in dune restoration

Organisation: Coastal Restoration Trust of New Zealand

Nursery pot trials evaluating koi carp as fertiliser

Preliminary investigation as an additive to potting mix

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Introduction

Koi carp are an invasive pest fish thought to have been imported into New Zealand accidentally in the 1960s. This noxious species resemble gold fish and are now widespread in Auckland and Waikato regions and are spreading into Northland, southern North Island and Nelson/Marlborough. Numbers have exploded in the rivers and lakes of the lower Waikato basin over the last 3 decades where they cause catastrophic habit loss for native fauna and flora and have a detrimental effect on water quality.

The Waikato Regional Council have been exploring the potential for a Carp-N Neutral project aimed at trapping carp and "digesting" them into fertiliser and other products to benefit environmental programmes. Fish traps screen carp and other pest fish including catfish while allowing smaller native species to pass through unharmed.

There are a range of potential uses for digested carp in community-based restoration. Preliminary investigation indicates it performs at least as well as commercial fertiliser tablets in Coast Care planting programmes using native sand binders. Other potential uses include propagation of native plants, animal repellents applied to foliage, and lures in bait stations for trapping predators.

Early trials indicate digested koi carp is excellent as an additive to potting mix in the propagation of native plants. Various other potential uses in the propagation of plants includes foliar application of the condensate and fish juice as a liquid fertiliser or as insect, bird and rodent protection as seedlings are being raised in the nursery. This report provides a summary of a set of pot trials using a

selected range of native plant species to evaluate potential uses of koi carp formulations compared to existing methods, including practical and economic considerations.

This 3-year project is jointly funded by the Ministry for the Environment's Community Environment Fund, and project partners Waikato Regional Council and the Coastal Restoration Trust of New Zealand. In-kind support is being provided by Beachcare and Coastcare groups and other regional councils including Northland RC and Bay of Plenty RC. Industry supporters include Coastland Plant Nursery and AgriSea New Zealand.

Coastlands Plant Nursery

Coastland Plant Nursery, also trading as New Zealand's National Coastal Sand Dune Revegetation Centre are one of the leading native plant producers in the country based in the Bay of Plenty. They raise 500,000 foredune and back dune plant species each year, specialising in propagating, growing and supplying quality eco-sourced native plants for sand dune replenishment and coastal erosion.

Specially built facilities allow them to propagate, grow and supply coastal natives for large environmental projects, Coastcare groups, councils and private landowners throughout NZ to meet a range of specifications in size and container type. Eco-sourcing is a huge part of their operation where they have a rigorous tracking system to ensure the seed sent in or collected by their staff is clearly identified as the source of the plants 12-18 months later.

Coastlands specialises in experimenting with different methods and products aimed at improving quality of plants, promoting environmental sustainability including reducing waste such as single-use plastics, evaluating organic options for producing plants, reducing their carbon footprint across all operations, implementing and promoting rigorous nationally recognised bio-security procedures, and in improving success of propagation of especially difficult to raise often vulnerable native plant species. This nursery is therefore ideally placed to evaluate use of koi carp as a potential organic replacement or supplement to standard nursery practices. A portion of the nursery was set aside for implementing and monitoring a range of koi carp treatments over the final year of this project.

Digested koi carp options

The digested carp produced and used as a fertiliser in the nursery trials was processed koi carp as a dry powder that had been pelletised with approximately 50% untreated sawdust to allow for pellets to be formed.

A nutrient-rich liquid (fish juice) that is tapped off the digesting fish was initially considered as a foliar spray as potential liquid fertiliser and to reduce foliage damage by insects and fungi, but this was abandoned due to major concerns in attracting rodents into nursery facilities.

Current nursery practice

Commercial plant nurseries mostly purchase ready-made potting mix from major firms like Daltons who supply bulk mixes that can be customised to suit individual nursery requirements including slow-release fertiliser. Coastlands use a Daltons GB Potting Mix comprising composted pine bark and bark fibre, cocofibre and 7mm pumice. A full complement of fertilisers including 3rd generation Osmocote Exact controlled release fertiliser, are added at recommended rates. Other additives are such as wetting agent and trace elements are included.

Options for supplementing the standard potting mix with koi carp were explored as part of nursery trials. Early field trials indicate fertiliser pellets derived from a mixture of koi carp and sawdust (required as a binder in the pelletising process) can be an effective slow release fertiliser giving similar results to petrochemical derived commercially available slow-release NPK fertilisers.

Trial design and treatments

Nursery pot trials were used as the basis for comparing koi carp fertiliser pellets with the standard commercially available potting mix with slow release petro-chemical based fertilisers incorporated.

Native species often used in riparian, coastal and wetland ecosystems were selected for comparative trials:

- Ti kouka - *Cordyline australis*
- Manuka - *Leptospermum scoparium* var. *scoparium*
- Wiwi - *Ficinia nodosa*
- Wharariki - *Phormium cookianum*
- Taupata – *Coprosma repens*
- Salt marsh ribbonwood - *Plagianthus divaricatus*

Two species that were planned to include in the trial *Muehlenbeckia complexa* and *Carex secta*, were not included as they were due to be potted the end of March when the nursery went into mandatory Government lockdown due to Covid 19.

Trials comprised 100 plants each for koi carp and control treatments. Plants were potted from plugs to final pot size of 1.4L plastic pots or Tinus root trainers with 20% koi carp pellets added to the standard potting mix for the koi carp treatment, after an initial test of 50% koi carp pellets may have contributed to the effects of too much nitrogen on plants. A bio pot trial using cardboard-based pots was also added for three species - ti kouka, taupata and manuka.

The plot trial was located within a sheltered open compartment of the nursery with pots placed on weed mat. Plants were temporary shaded for one month after planting. Seedlings were irrigated using overhead automatic watering as per standard nursery practice. Coastlands Nursery is located in a warm lowland environment 3 km inland from the coast near Whakatane, Bay of Plenty. Plants were grown for up to 10 months before planting out.

A feature of the processed koi carp is a pungent smell with the pelletised fertiliser. There was a concern with creating a rodent, dog or cat issue during storage, preparation and use of the koi carp formulations including any health and safety issues. Use of the fertiliser product by Coastcare groups had not been an issue so the expectation was that handling and use in the nursery due to the odour would not likely to be a problem.

Assessment of seedlings across both treatments was carried out at 3 and 6 months after planting with a full assessment compromised by the Covid-19 lockdown. However, subjective assessments of foliage colour and plant health were completed by nursery staff.

Results

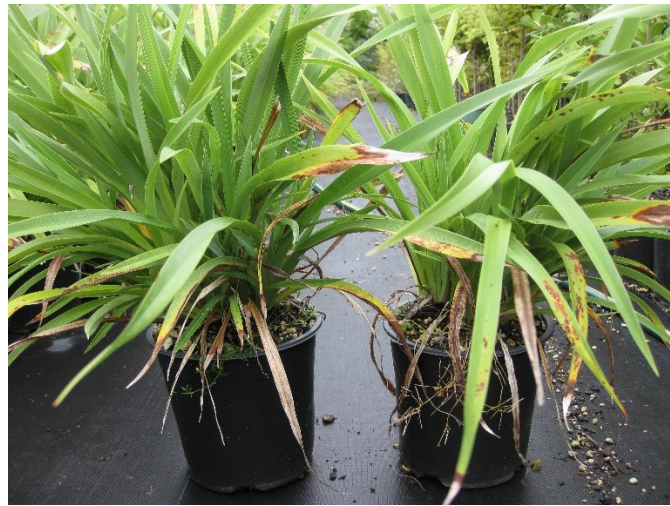
Phormium cookianum

- Grade: 1.4L Pot
- B29404 100 plants Koi Carp, Area Z9. B29236 100 plants Control, Area Z9
- Potted 15/11/19 estimated time in pot until ready for sale 6 months (May)
- 20% Koi carp pellets added into our standard Potting mix. Grade 1.4L pot.
- Situation: Outside open
- Pots were ¼ filled with potting mix, then Koi carp pellets were added to the pot, under and around the roots in measuring container.

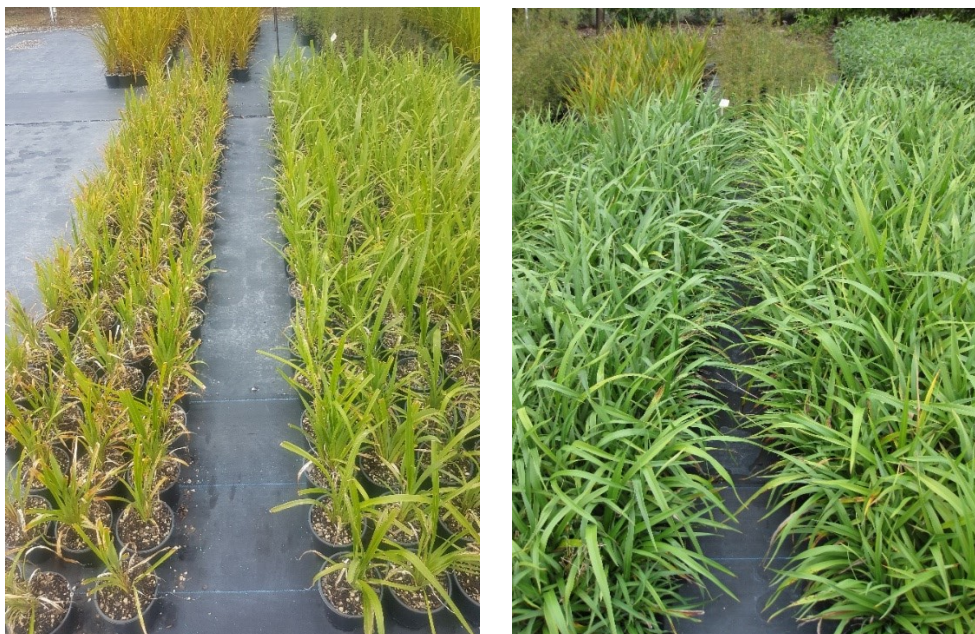
- Consideration was given to whether to add the Koi Carp pellets to a bulk potting mix and mix but concern was raised that because of the size of the pellets they would mix unevenly and not give a true message per pot resulting in uneven trial.
- The average staff member pots 100 plants per hour including placement, with adding the extra step this slowed the process by 100% taking 2 hours to complete by one staff member.
- For the first 8 weeks the *P. cookianum* suffered from the overload of Nitrogen, or the Koi Carp took all the nitrogen out of the mix while it was composting.
- Because of the immediate effects on the plants our response for all further plant trials were completed at 10% koi carp to potting mix per plant.

Final evaluation:

Koi Carp *P. cookianum* were greener in colour but the same size in diameter and height. The Koi Carp had possibly broken down enough for the nitrogen now to be available to the flax.



Koi carp 20% (left) Control (right)



Wharariki at 4-week stage December (left) and completion April (right)

***Leptospermum scoparium* Manuka**

- Grade: Roottrainer Tinus (RTT)
- B29522 240 plants Koi Carp, Area Z3-C. B29225 240 plants Control, Area Z3-D
- Potted 17/01/20 estimated time in Roottrainer until ready for sale 4 months (May)
- 10% Koi Carp pellets added into our standard Potting Mix.
- Situation: Pricked out moved Shade house then when 15cm high moved Outside- open
- When Koi Carp was used in Roottrainers, a small amount of potting was placed in the bottom of roottrainer with Koi carp then added and more potting mix on top so Koi carp was placed one third down roottrainer.
- The plant roots pricked out on top were not immediately touching the Koi carp. Again, it was easier to add with a measured scoop to each roottrainer.
- Mixing into the potting mix first would have made uneven amount of koi carp per cell due to the size of Koi carp pellets, which are larger than the potting mix particles.
- The average staff member fills 5 trays (240 cavities) in 5 minutes, with adding the Koi Carp step the time was 15 minutes for 5 trays.



No difference in height between fertiliser treatment for manuka although koi carp fertilised plants were greener than non-fertilised plants.

Final Evaluation

A slight difference in colour of the Manuka, with koi carp plants slightly greener, no difference in size or height.

***Ficinia nodosa*- Knobby club rush or Wiwi**

- Grade: Roottrainer Tinus (RTT)
- B29525 240 plants Koi Carp, Area Z3-C. B29526 240 plants Control Area Z3-C.
- Potted 20/01/20 estimated time in Roottrainer until ready for sale 4 months (May)
- 10% Koi Carp pellets added into our standard Potting Mix.
- Situation: Pricked out moved to Shade house then when 15cm high moved Outside- open

Final Evaluation

A slight difference in colour, with koi carp plants slightly greener, not difference in size or height.

***Cordyline australis* Cabbage tree or Te kouka**

- Grade: Roottrainer Tinus (RTT)
- B29537 240 plants Koi Carp, Area SH. B29538 240 plants Control, Area SH.
- Potted 28/01/20 estimated time in Roottrainer until ready for sale 4 months (May)
- 10% Koi Carp pellets added into our standard Potting Mix.
- Situation: Pricked out moved Shade house where they are still growing

Final Evaluation

A slight difference in colour, with Control plants slightly greener, opposite to all other plant species but no difference in size or height.



Ti kouka or cabbage tree – control (left) and Koi Carp (Right)

Plagianthus divaricatus- Salt Marsh Ribbonwood

- Grade: Roottrainer Tinus (RTT)
- B29534 240 Plants Koi Carp, Area SH. B29468 240 plants Control, Area SH.
- Potted 28/01/20 estimated time in Roottrainer until ready for sale 4 months (May)
- 10% Koi Carp pellets added into our standard Potting Mix.
- Situation: Pricked out and moved to Shade house

Final Evaluation

A slight difference in colour, with koi carp plants slightly greener, but no difference in size or height of seedlings.

***Cordyline australis* Cabbage tree or Te kouka**

- Grade 1Litre pot and 1Litre Bio pot (cardboard based)
- B29539 100 plants Koi Carp 1L bio pot, Area 51. B29541 100 plants Koi Carp 1L pot, Area 51.
- B29577 100 plants Control 1L bio pot, Area 51. B28954 100 plants Control 1L pot, Area 51.
- Potted 30/01/20 estimated time in pot until ready 4 months (May)
- 10% Koi Carp pellets added into our standard Potting Mix.
- Situation: Hardened off growing on lines in open space then potted and placed in outside area with temporary shade cover.



From left to right – Koi carp 1L, Control 1L, Koi carp bio pot control, and bio pot Koi carp.

Final Evaluation

A slight difference in colour, with Control plants slightly greener is again is opposite to all other plant species and no difference in size or height. Note that the cardboard based pot version where breaking down within 6 months of potting into these containers.

Coprosma repens Taupata

- Grade 1Litre pot and 1Litre Bio pot (cardboard based)
- B29556 100 plants Koi Carp 1L Area Z3-C. B29559 100 plants Koi carp Bio pot, Area Z3-C.
- B29557 100 Plants Control 1.3L Z3-C
- Potted 04/02/20 estimated time in pot until ready 3 months (May)
- 10% Koi Carp pellets added into our standard Potting Mix.
- Situation: Hardened off growing on lines in open space then potted and placed in outside area with temporary shade cover. Cover removed after 1 month.



Taupata - left to right: Koi Carp Bio pot, Koi Carp 1Lpot and Control

Final evaluation

Taupata treated with Koi Carp were greener in colour but the same size in root collar diameter and height. The Koi Carp has possibly broken down enough for the nitrogen now to be taken up by the plants. The control has used all available nitrogen and is now yellowing off- top-up fertilizer required.

***Leptospermum scoparium* Manuka**

- Grade 1Litre pot and 1Litre Bio pot (cardboard based)
- B29559 100 plants Koi carp 1L, Area 51. B29598 100 plants Koi Carp Bio pot, Area 51.
- 29626 100 plants Control Bio pot, Area 51. B28919 100 plants Control 1L, Area 51.
- Potted 10/03/20 estimated time in pot until ready for sale 3 months (May)
- 10% Koi Carp pellets added into our standard Potting Mix.
- Situation: Hardened off growing on lines in open space then potted and placed in outside area with temporary shade cover. Cover removed after 1 month.

Final Evaluation

A slight difference in colour, with koi carp plants slightly less green but minimal, no difference in size or height.



Manuka in plastic and biodegradable cardboard plot 6 months after potting on. From left to right: Koi carp 1L pot, Koi carp Bio pot, Control 1Lpot and Control Bio pot

Conclusions and recommendations

- As expected the koi carp fertiliser pellets attract rodents, particularly mice which are a major factor in native plant propagation facilities, especially for seed storage, sowing and early germination stages.
- The koi carp trial could not be extended to evaluating benefits to propagation of the two key native sand binders spinifex and pingao due to the risk of rats and mice invading the crop houses at the time of germination. The koi carp proved to be a strong lure.
- The cost of time taken to add the Koi carp to potting mixes weighted heavy against the benefit of the slightly greener looking plants. The koi carp while helping keep the plant greener which could be easily replicated by adding a top-up fertilizer in March.
- The two wetter plant species, ti kouka and manuka did not perform as well as the drier plant species with the addition of koi carp.
- A further problem was the chunky pellets were cumbersome to load into pots in mixture with standard potting mix. A different mechanized system for adding the Koi carp pellets would need to be used to get the cost down. There is the possibility of adding the koi carp to the potting mix as the potting mix is made. However, there is concern that the large koi carp pellets may be concentrated in the base of bulk potting mix piles.
- Koi Carp pellets could be used as a top fertilizer to add to potting mix were the potting mixes may sit for a time with out being used. This may be more suited to community based nurseries where potting on operations are subject to irregularities in timing due to a volunteer base and limited resources.
- Commercial native plant nurseries are likely to be less interested in adopting koi carp as a fertiliser additive to potting mixes as these are commercially prepared in bulk. Most medium to large nurseries do not mix their own potting mix, rather suppliers such as Daltons provide mixes to order and delivered by truck and trailer.
- A large sustainable supply of koi carp would be required to supply potting mix specialists with sufficient product for suppliers to market and supply of a potentially specialised organic mix of koi carp fertilised potting mix.
- However, scope exists for community and iwi based nurseries to use koi carp in organic based potting mixes in production of native plants.