# Preliminary Field Trials with a Palatable Form of Norbormide

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**ABSTRACT:** Field trials are reported in this paper on a new bait containing 1% norbormide. Two separate field trials were recently completed on commercial chicken farms in South Auckland, New Zealand. Norway rats were abundant both inside the farm sheds and around the surrounding farmland. Monitoring undertaken before toxic baiting recorded high levels of rat activity. Post-treatment monitoring found no rat paw prints in any of the tracking tunnels from Site 1, and in only one tunnel at Site 2. The decrease of 100% and 96%, respectively, represented a marked reduction in the Norway rat population at both sites.

**KEY WORDS:** bait, field trial, norbormide, Norway rats, rat-specific, *Rattus norvegicus*, rodenticide

**Proceedings, 29th Vertebrate Pest Conference** (D. M. Woods, Ed.)
Paper No. 55. Published December 10, 2020. 3 pp.

## INTRODUCTION

The extreme susceptibility of rats (*Rattus* spp.) to norbormide has been known for some time (Roszkowski 1965, Russell 1965, Poos et al. 1966). Death results from circulatory disorders and heart failure (Cavalli et al. 2004, Ricchelli et al. 2005). Norbormide is highly toxic to members of the genus *Rattus* compared with other mammals or birds (Roszkowski et al. 1964). Rats are 150-fold and 40-fold more sensitive to norbormide than house mice (*Mus musculus*) and guinea pigs (*Cavia porcellus*), respectively, while most other mammals and birds tested are >200-fold less sensitive (Roszkowski et al. 1964).

Taste aversion had limited its effectiveness, and field efficacy results were generally poor (Prakash 1988). Anti-coagulant rodenticides have a major role in the control of rodents globally for both crop protection and conservation (Russell and Broome 2015). Their slow onset of action helps ensure that even wary rodents will ingest sufficient toxic bait to cause death (Eason et al. 2017). More recently, following the discovery of residues of the second-generation anticoagulants in wildlife (Young and De Lai 1997, Stone et al. 1999, USEPA 2004, 2008, Murray 2011, Crowell et al. 2013, Murray 2017), and questions about their humaneness (Littin et al. 2002, Mason and Littin 2003), interest in non-anticoagulants, or at least less-persistent low residue pesticides, has revived and research on a range of acute acting toxicants including norbormide has advanced (Eason et al. 2017).

Different ways of improving the effectiveness of norbormide and producing it in a more palatable form include earlier research by Rennison et al. (2007), this has significantly enhanced our understanding of the optimal physico-chemical characteristics of norbormide that influence palatability and effectiveness (Jay-Smith et al. 2016). Optimising the method of synthesizing norbormide has now resulted in a form of norbormide that has been proven to be palatable in cage trials with Norway rats (*R. norvegicus*) and wild captured ship rats (*R. rattus*) (Shapiro et al. 2018). This paper focuses on field trials with the same norbormide.

## METHODS

Two field trial sites both south of Auckland were selected. Both sites are primarily used as commercial chicken farms for raising broiler hens. Both chicken farms consist of three grow sheds, each approximately 80 m × 14 m in size, and spaced between 10 m to 15 m apart.

Tracking tunnels are frequently used to estimate rodent abundance in New Zealand. They consist of a plastic tunnel (10 cm × 10 cm × 50 cm) that houses a piece of cardboard (measuring 49 cm × 10 cm) with a small section of ink (19 cm × 10 cm) in the centre of the card. As rodents move through the tunnel they step on the ink and leave paw prints on the blank section of card. The prints are then analysed and identified to the species level. Tunnels were baited with peanut butter and placed against the sides of the sheds to increase the chances of rodents entering and being detected. A total of 24 tracking tunnels were used at each site and each tunnel was placed within 2 m of a bait station. The tracking rates were expressed as the percentage of tunnels at each site hat recorded rat prints. Tracking rates were calculated for monitoring undertaken pre and post toxic control and the change in tracking rates were used to determine the change in relative abundance of Norway rats and the efficacy of the norbormide paste bait.

A total of 24 tamper proof rodent bait stations were deployed at each trial site and each bait station was

**Table 1. Norbormide field trial results.**

| Field Trial Site | Tracking Tunnels that Recorded Rat Presence (%) | | | Number of Tunnels with Bait Take | | Total Toxic Bait Consumed (g) |
|---|---|---|---|---|---|---|
| | Pre-Control (n = 24) | Post-Control (n = 24) | Reduction in Rat Tracking | Non-toxic Pre-feed (n = 24) | Toxic Baiting (n = 24) | |
| Site 1 | 79% | 0% | 100% | 24/24 | 24/24 | 1477.9 (11.5 -100.0) |
| Site 2 | 100% | 4.2% | 96% | 24/24 | 22/24 | 390.3 (0.9 - 100.6) |

loaded with 100 g of non-toxic paste bait. Pre-feeding was undertaken to ensure that rats were readily feeding on baits before deploying toxic baits. At Site 1 pre-feeding was undertaken over 15 consecutive days and nights and bait stations were checked on six occasions during this time. On each occasion, any bait station with bait take was topped up to 100 g. At Site 2 pre-feeding was undertaken over 21 consecutive days and nights and bait stations were checked on eight occasions. On each occasion, any bait station with bait take was topped up to 100 g.

Following the removal of the non-toxic pre-feed paste, bait stations were left empty for three nights and then each bait station was loaded with 100 g of paste bait containing 1% norbormide. Paste bait was manufactured at Connovation Ltd, East Tamaki, Auckland. Once toxic baits were deployed at both sites (Day 1), bait stations were checked and weighed the following day (Day 2) and then on Day 5. During site visits on Days 2 and 5, each bait station with paste bait inside was weighed (to the nearest 0.1 g) and topped up to 100 g. On Day 8 all toxic bait was removed from bait stations and post-monitoring with tracking tunnels and cards was undertaken starting that same day.

## RESULTS

### Site 1

Rat monitoring undertaken before toxic baiting recorded 79% Rodent Tracking Index (RTI). Non-toxic pre-feed paste bait was deployed in rodent bait stations and topped up every three days; pre-feeding was continued for 15 continuous days. Pre-feeding recorded high levels of bait take. During the eight consecutive days of toxic baiting, a total of 1,477.9 g (range per bait station 11.5-100.0) of toxic bait was taken from the 24 bait stations at the site. Norway rat carcasses were found throughout the site during the toxic baiting and those carcasses were located within 5 m of a bait station. Following toxic baiting, post-treatment monitoring was undertaken and found no rat paw prints in any of the 24 tracking tunnels from Site 1. The toxic treatment achieved a 100% reduction in rat tracking from the pre-treatment monitoring to the post-treatment monitoring at Site 1. (Table 1)

### Site 2

Rat monitoring undertaken before toxic baiting recorded 100% RTI. Pre-feeding recorded high levels of bait take. Non-toxic pre-feed paste bait was deployed in rodent bait stations and topped up every three days; pre-feeding was continued for 21 continuous days. During the eight consecutive days of toxic baiting, a total of 390.3 g (range per bait station 0.9-100.6 g) of toxic bait was taken from 22 of the 24 bait stations at the site. Following toxic baiting, post-treatment monitoring was undertaken and only one tracking tunnel out of the 24 deployed (4.2% RTI) recorded any rat paw prints, and that was only one set of prints. The toxic treatment achieved a 96% reduction in rat tracking from the pre-treatment monitoring to the post-treatment monitoring at Site 2. (Table 1)

## CONCLUSIONS

Two field trials have demonstrated the field effectiveness of a new rodenticide bait containing 1% norbormide that has been recently shown to be palatable and effective in cage trials (Shapiro et al. 2018). The decrease of 100% and 96% in rat activity respectively represents a marked reduction in the Norway rat population at both sites and indicates significant potential for this toxin as an alternative to conventional broad-spectrum rodenticides.

Norbormide meets many of the desirable features of an ideal rodenticide. These include 1) specifically lethal to the target species, 2) relatively humane, 3) orally active and rapidly absorbed, 4) relatively short half-lives in blood and tissues vs. many other rodenticides, 5) not persistent in the environment, and 6) does not lead to secondary poisoning. Pharmacokinetic studies indicate norbormide is readily metabolized and unlikely persist (Ravindran et al. 2009a,b) and secondary poisoning studies conducted by Russell (1965) showed no ill-effects in cats, dogs, and pigs. Humans given large doses exhibited a slight decrease in blood pressure which normalized after two hours (Hayes and Laws 1991); there is no antidote for norbormide (e.g., in the case of accidental ingestion by children or pets).

Given the positive attributes, it is not surprising that there have been several attempts to further increase the effectiveness of norbormide. An encapsulation approach is reported by Nadian and Lindblom (2002) and prodrug forms of norbormide have been developed that aim to delay the action of the toxicant and increase palatability by masking the taste (Rennison et al. 2012). Our approach has been somewhat different and has not been without similar challenges. Campbell et al. (2015) suggested that at the current rate of development, it is expected new forms of norbormide could be registered and available for field use within the next five years. This has not yet happened but these results are a step in the right direction and further field trials in areas with Norway rats and ship rats are planned in 2020/21.

## ACKNOWLEDGEMENTS

Invasive Pest Control Ltd and Duncan MacMorran are acknowledged for sourcing norbormide from many different manufacturers worldwide and independently supporting research that compared the efficacy of each batch and identified an effective formulation for these field trials. Predator Free NZ is acknowledged for their support of planned field trials.

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