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Field Testing of a New Feral Hog Feeder to Minimize Bait Exposure to Non-target Wildlife

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ABSTRACT: The feral hog is an invasive species that inflicts billions of dollars in agricultural damage every year in the U.S. Hog-specific baits have shown promise in reducing feral hog abundance but require species-specific feeders to exclude domestic animals and non-target wildlife. Four feeder types were tested during 2016 and 2017 field studies, including commercial feeders, prototype feeders, and a new species-specific feral hog feeder. Commercial feeders with 2.3 kg, 4.5 kg, and 6.8 kg weighted doors were used in 2016 and raccoons were observed on camera opening doors 10 times out of 164 camera observed visitations (6.1%). No other non-target species were observed entering the feeders. The following year, new feeders with 7.7 kg double-sided guillotine doors were used in a field study and no raccoons opened doors during 153 camera-observed visitations. Out of over 1,600 non-target camera images recorded, only one mouse was observed inside the feeders. Results of this study suggest the new hog feeder may provide reduced-risk to non-target species and a promising tool for controlling hog populations.

KEY WORDS: bait, feral hog, non-target species, species-specific feeder, *Sus scrofa,* toxicant, warfarin, wild pig

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INTRODUCTION

The feral hog (*Sus scrofa*) is one of the most widespread, invasive mammals in the world. Its native range spans from Western Europe to the eastern edge of Asia and southward into Northern Africa and Indonesia (Sjarmidi and Gerard 1988). Feral hogs are also found in North America (Barrett 1978), South America (Coblentz and Baber 1987), and Australia (Flynn 1980) where they are highly invasive (Woodall 1983). Feral hogs currently inhabit 44 U.S. states (Lapidge et al. 2011).

Invasive feral hogs damage natural ecosystems in numerous ways such as decreasing biodiversity, interrupting trophic interactions, and outcompeting native species (Gibbons et al. 2000, Roemer et al. 2002). Hogs decrease biodiversity by reducing native flora and fauna through predation and habitat degradation (Singer et al. 1984, Massei and Genov 2004, Seward et al. 2004). Results of one study at Fort Benning, Georgia, estimated the feral hog population consumed 3.16 million herpetofauna within the 220 km^2 area each year (Jolley et al. 2010). In the Galapagos Islands, feral hogs are one of the top predators of Galapagos tortoises and other endemic species (Cruz et al. 2005). Feral hogs extensively damage forests, where their rooting can interrupt ecological succession (Bratton 1975). In Hawaii, more than 80% of the soil in hog inhabited areas was devoid of vegetation (Kurdila 1995) and areas of the Olaa-Koa rainforest took approximately 16 years to recover from feral hog damage (Cole et al. 2012). As a result of the omnivorous diet of feral hogs, they often compete with native species for food (Baber and Coblentz 1987).

Feral hogs are detrimental to agricultural endeavors as well. Each year in the U.S., over six million feral hogs inflict approximately $2.5 billion dollars in damage attributable to destruction of agricultural crops, spreading of disease, depredation of livestock, and cost associated with control efforts (Frey 2017). In the southern U.S., feral pigs damage soybean, cotton, grain, peanut, hay, and cause various other agricultural and environmental damage (Rollins 1993). The rooting behavior (using snout to dig through soil) is also damaging because it increases erosion (Rollins 1993). Feral hogs harbor and spread diseases such as brucellosis, pseudorabies, and trichinosis to humans and livestock (Davis 1998).

Lethal and non-lethal methods have been used to reduce feral hog populations, but the standard removal methods of hog hunting and trapping can be ineffective because of several factors. Feral hog populations have high birth rates, with sows becoming sexually mature at 3-4 months of age (Johnson et al. 1982), producing up to three litters per year (Giffin 1978), and giving birth to 3-14 piglets at a time (Comer and Mayer 2009). These animals are also opportunistic omnivores that can survive on almost anything edible (Sweeney et al. 2003). These problems are exacerbated by illegal movement and introduction facilitated by humans (Spencer and Hampton 2005). Toxicants have been used to control feral hogs in Australia, being largely more cost-effective and successful than hunting or trapping (Choquenot et al. 1996). Although baiting with toxicants is a potential tool for controlling feral hog abundance, hog-specific feeders are required to minimize the risk presented to non-target wildlife.

The Hog Hopper™ (Animal Control Technologies Australia, Somerton VIC 3062, Australia), another species-specific feeder, is a cube-shaped design with an interior divider and 2 guillotine doors on opposite ends (Campbell et al. 2012). Although conceptually the design is sufficient to condition feral hogs to feed, the station is too light-weight to deter non-target wildlife and domestic animals.

Figure 1. Comparison of Hog Stopper™ feeder with 7.7 kg guillotine doors (left photo) and Brower® commercial feeders with 4.5-kg steel bars attached to doors (right photo).

For a toxicant to be approved for use in the U.S., research must be conducted to ensure non-target species do not have access to bait presented in the environment. In past studies, non-target species have been able to access various types of commercial hog feeders and no toxicants for feral hogs have been developed. To address this issue, species-specific feeder systems are needed (Long et al. 2010). The first feral hog toxicant for use in the U.S. was approved by the U.S. Environmental Protection Agency (EPA) on 3 Jan. 2017. The product, Kaput® Feral Hog Bait (warfarin bait) (Scimetrics Ltd. Corp., Wellington, CO), contains 0.005% warfarin, a concentration 80% below commercially available rat and mouse bait formulations. A hog specific feeder, the Hog Stopper™ (Scimetrics Ltd. Corp., Wellington, CO) (Poché 2015) was designed, to address shortcomings other feeders have shown in excluding non-target wildlife species. The current version of the feeder is durable, affordable, and easily deployed while still encouraging feral hog feeding and excluding non-target wildlife.

This paper describes two field studies, conducted in north Texas during 2016 and 2017, during which we evaluated the ability of various hog-specific feeders to prevent non-target species from accessing the inner contents. Our objective was to quantify non-target access to the Hog Stopper™ and modified commercial feeders.

METHODS

Trial 1-2016

Trial 1 was conducted in Briscoe, Floyd, and Motley counties in northern Texas (34°17'28" N latitude, -100°59'26" W longitude), was conducted between May 6 and July 14, 2016. The study area was comprised of private land used for commercial agriculture and hunting. Study sites were selected based on diversity of habitat for feral hogs and other wildlife, landowner permission, and proximity to dirt roads. The EPA issued an Experimental Use Permits (EUP No.72500-EUP-2 and EUP No.72500-EUP-3) to Scimetrics Limited Corp. (Wellington, CO) to enable field testing of warfarin bait. This experiment was part of a larger warfarin baiting campaign which generated efficacy data to support an EPA product registration.

Three plots, approximately 5 km^2 each, were selected and separated by approximately 5 km. Two plots were treated with warfarin bait and one served as the control with no bait applied. Each plot had feeders placed in areas of feral hog activity discerned by tracks and trails, wallows, vegetation damage, visual sightings, or trail cameras. The study was composed of four sampling periods: conditioning, pre-treatment, treatment, and post-treatment. During the conditioning period, the feeder doors were secured open for about three weeks and filled with whole corn to attract feral hogs. At the start of pre-treatment, doors were lowered for three weeks to limit non-target access and continued to be filled with corn *ad libitum*. Doors remained lowered for the remainder of the study. At treatment initiation, feeders within both warfarin-baited plots were filled with Kaput® Feral Hog Bait containing 0.005% warfarin. The control plot had feeders filled with whole corn. After the 4-week baiting program, the toxicant was removed and replaced with corn and consumption was monitored (post-treatment).

Four hog feeder models were used in this study: two commercial hog feeder models (20 Brower Equipment #22H double door feeders; Hawkeye Steel Products, Houghton, Iowa), and 70 Miller #HGFD double door feeders (Miller Manufacturing Company, Glencoe, Minnesota). In addition, two HogHopper™ feeders and one similar guillotine door prototype were also used (Figure 1).

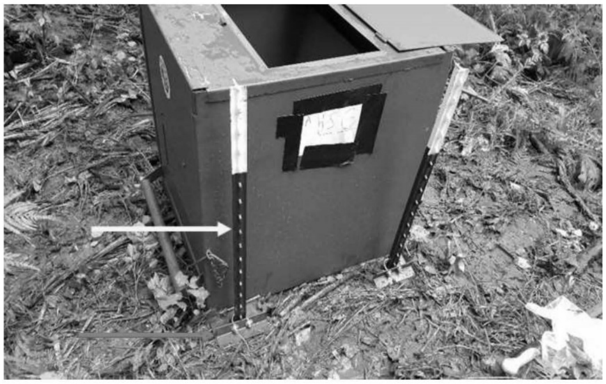

Figure 2. All Hog Stopper™ feeders are secured to the ground with v-bolts and studded t-posts which keep non-targets from tipping them over.

Each of the two treatment plots had one HogHopper™ while the control plot had one guillotine door prototype. The three study plots had 11 feeder clusters each, 10 of which were composed of three commercial feeders side-by-side. One feeder cluster on each plot had a single custom guillotine door feeder or HogHopper™ feeder. Feeders were secured to the ground using wire and studded t-posts or trees (Figure 2). During the pre-treatment, 4.5 kg metal bars were bolted to the commercial feeder doors to deter non-target species but still encourage feral hog food conditioning. During treatment, the commercial feeder doors were fitted with 4.5 kg metal bars, as the hogs were conditioned to the feeders and this added weight helped deter non-targets from accessing toxic bait. One feeder cluster on the second treatment plot was supplied with 6.8 kg metal bars during the treatment and post-treatment periods because there were markedly large raccoons seen during the pre-treatment period.

Trail cameras (Primos Hunting Truth® Cam 40, Primos Hunting, Flora, MS; Stealth Cam STC-P12 and Stealth Cam STC-G42NG, Stealth Cam, LLC, Grand Prairie, TX) were placed at each station to capture feral hog feeding activity and non-target feeder access. Cameras were checked, and images were downloaded every 1-5 day throughout the study. All images were reviewed to determine wildlife visitations recorded by species, numbers, and frequency. The number of individuals of each non-target species and total time spent at feeders were recorded on treatment plots during treatment periods. Visitations were tallied and defined as an animal approaching within 10 m of the feeder and remaining for a minimum of 10 minutes.

Feeders were monitored for activity and consumption every 1-5 days depending on weather and access road conditions. During feeder checks, any spillage of the bait recovered outside the feeder was collected. Spillage recovered was assigned to the closest feeder, collected, and placed into labeled resealable plastic bags. Spillage was weighed to the nearest 0.1 g with an appropriately calibrated balance (Ohaus Scout® Pro SP4001) and recorded.

Trial 2- 2017

During Trial 2, newly designed Hog Stopper™ prototypes were manufactured by Erbes Welding (Greeley, Colorado) and used at field sites in north Texas, near the town of Turkey (34°17'28" N latitude, -100°59'26" W longitude). The feeder is similar in design to the HogHopper™ with two opposing guillotine doors and an internal divider, but also has an angled bar. This feeder is made of steel, with a 16-gauge body, 14-gauge doors, and 12 design modifications. The Hog Stopper™ weighs 63.5 kg with 7.7-kg doors.

This study took place from February 16 through May 2, 2017, approximately 125 km southeast of Amarillo, Texas. The study area was comprised of private land used for agricultural and hunting purposes. The surrounding landscape comprised of crop land, pasture, and river bottoms with shrubs and trees consisting mainly of shrubby mesquite (*Prosopis* sp.), juniper (*Juniperus* sp.), cottonwood (*Populus* sp.), and shinnery oak (*Quercus havardii*). The main criterion for study site selection was evidence of established feral hog populations. There were two test plots and one control plot. Ninety (90) Hog Stopper™ feeders were used on the three plots with 10 clusters of three feeders each in the control and treatment areas. At each location, feeders were set approximately 1 m apart and secured with t-posts.

Kaput® Feral Hog Lure (Scimetrics Limited Corp.), a non-toxic flavored cracked corn, was used as an attractant during the conditioning, pre-treatment, treatment and post-treatment phase of the study. Camera data were collected in the same manner as the 2016 study. The number of attempts by feral hogs and non-target wildlife to access bait during the treatment period within treatment plots was recorded and quantified.

RESULTS

Trial 1- 2016

The majority of non-target feeder visitations were by raccoon, deer, and wild turkey (*Meleagris gallopavo*). Raccoons were the only species able to lift commercial feeder doors and did so 10 times out of 164 total visitations (6.1%) (Table 1). Deer approached feeders on 33 occasions and were unable to raise doors with their muzzles. Results of this study indicated 4.5 kg weights restricted nearly all raccoons from accessing feed in double-door feeders, with the exception of several large individuals. On the treatment plot where the 6.8 kg door-weights were installed on feeder doors, no raccoons reached food contents. No photos showed raccoons retrieving feed in the HogHopper™.

Trial 2-2017

Of the 90 Hog Stopper™ feeders on all plots, there was only one mouse seen to enter a feeder during >1,600 wildlife visits (0.06%) (Table 1). Most feeder approaches throughout the study were by raccoon, deer, and bird species. After doors were lowered, the Hog Stopper™ excluded wildlife species from reaching feeder contents. No raccoons were able to access the placebo or bait out of 153 visits and attempts. Deer approached feeders 178 times and did not obtain feeder contents.

Table 1. Wildlife observed by camera near hog-specific feeders during 2016 and 2017.

Non-Target Species Observed	Trial 1 - 2016		Trial 2 - 2017	
	Feeder visitation(s)	Feeder Entry	Feeder visitation(s)	Feeder Entry
Raccoon	164	10	153	0
Deer	33	0	178	0
Turkey	43	0	25	0
Rat / Mouse	38	0	24	1

Table 2. Cumulative bait spillage collected from 30 feeders in studies conducted in Northern Texas in 2016 and 2017.

Trial Year	Total Bait Spillage (g)	Total Warfarin Spilled (mg)	Warfarin Spilled/Feeder (mg)
2016	264.8	13.3	0.4
2017	3,843.3	192.2	6.4

Table 3. Comparison and characteristics of guillotine door hog feeders.

Feeders	HogHopper™	HogStopper™
Weight (kg)	27.7	57.2
Door weight (kg)	3.5	8.2
Secure feeder with	Rods	T-Posts
Raccoon success accessing feeder	Yes[1]	No

[1]Campbell et al. 2012

Spillage

Test bait spillage varied each year. In 2016, bait spillage was 264.8 g over a 6.7 km^2 area (13.3 mg warfarin/km^2) (Table 2). During 2017, 3.8 kg of bait was spilled over 3.3 km^2 (58.5 mg of warfarin/km^2). The difference was attributed to the 2016 formula being finely cracked corn as compared to the 2017 bait which consisted of more whole corn.

DISCUSSION

Although all feeders had success at preventing non-target access to bait, the Hog Stopper™ was the most effective at preventing entry into the units to retrieve contents. Commercial feeders can be modified providing sufficient weight is added to the doors. A minimum of 6.8 kg steel bar should be attached to the distal portion of the inclined doors on commercial feeders. Hog Stopper™ door weights should be a minimum of 7.7 kg to prevent raccoons from entering feeders.

Results of a pen study conducted by Snow et al. (2017) suggested raccoons can lift 10.9 kg feeder doors/ lids when 80% of daily food ration was withheld. Although the door on the Hog Stopper™ weighs 7.7 kg, no raccoon was able to lift the device and reach the contents. This is attributed to not only the door weight but also the design and mechanics of the guillotine doors. The feeders used during the Snow et al. (2017) study, named Resistance Assessment Bait Stations (RABS), were boxes measuring 55 × 29 × 31 cm, constructed out of 4.4-cm-thick pine wood. The lids had a 5-cm overhang on the front of the box which provided a lifting point for feral hogs and raccoons. Raccoons were able to access feeders because of the hinge (fulcrum) and the placement of the lever. On the RABS, as the lid is lifted, the fulcrum takes on more of the weight, requiring less force to lift the door. The commercial feeders used in this study during 2016 were similar to the RABS, with a higher lip and the presence of a hinge. With the guillotine style doors on the Hog Stopper™, there is no fulcrum to deter the animal as it lifts the lever. The weight is raised vertically, which is more difficult. Hence, the ability of raccoons to enter feeders is dependent not only on weight, but on physics. The design and physics of the feeder plays an important role in excluding wildlife. The HogHopper™ and Hog Stopper™ comparisons are presented in Table 3.

The lever placement on the guillotine doors is also more difficult for non-target species. To lift the doors, the animal must apply force directly underneath the bar. On the RABS, it is easier to access from underneath the lid because since it is 31 cm above the ground compared to 6.4 cm, which is the distance from the bottom of the bar to the ground on the Hog Stopper™. Raccoon body mechanics might not be sufficient to lift feeder doors and future laboratory studies would be useful in confirming this theory.

The amount of feed spillage recovered during both studies was more a byproduct of the bait matrix (cracked corn versus whole corn) than of the feeder design. During the 2016 study, non-target spillage increased because feeders were more easily entered. In 2017, no non-target species were able to lift the feeder doors, and any spillage was the result of feral hogs. When hogs lifted the doors to consume bait, the corn was easier to push out of the feeder. Piglets readily ate smaller crack corn spillage compared to whole corn. The increase in spillage could have been a result of the number of hogs visiting feeders. Some trail camera images had more than 30 hogs in a single photo trying to obtain food from a cluster of three feeders. As more hogs feed from the feeders, the dominant ones become more aggressive and force others away from the food source. The number of hogs counted at feeders on treatment plots in 2016 and 2017 was 107 and 1,351 respectively. In the three years of efficacy trials conducted in Texas, the initial paraffin formulation was used in 2015 and resulted in little spillage because of hog feeding behavior. For this reason, the paraffin-based product was selected for the EPA Kaput® Feral Hog Bait formula.

MANAGEMENT IMPLICATIONS

Our research has shown species-specific feeders can be used to limit non-target access to toxicants, while still promoting feral hog bait consumption. The Hog Stopper™ was very effective at limiting non-target access and should be considered by farmers and conservationists alike. As feral hog numbers increase, the Hog Stopper™ could prove to be an invaluable tool in delivering toxicants to control feral hogs in the U.S. and other countries.

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