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Field Evaluations of Broadcast, and Individual Mound Treatments for Red Imported Fire Ant, *Solenopsis invicta* Buren, (Hymenoptera: Formicidae) Control in Virginia, USA

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Abstract

Field evaluations were conducted to determine efficacy, residual activity, and knockdown potential for fire ant control products. Broadcast granular products (Advion, 0.045% indoxacarb; and Top Choice Insecticide, 0.0143% fipronil) were individually evaluated, and compared with a combination of two products applied together, and with individual mound applications of Maxforce Fire Ant Killer Bait (1.0% hydramethylnon). After application, the greatest percent reductions (90 days) were observed in the Advion/Top Choice combination plots (100.0%), followed by Top Choice alone (96.4%). Advion and MaxForce produced significantly lower foraging reductions at 90 days (61.2% and 27.5% respectively). At the conclusion of the test (day 360), significantly fewer ants were collected in the Advion (777.7), Top Choice (972.8), and combination plots (596.2) than in the control plots (1257.8) (*df* 13, $F = 8.3$, $P < 0.05$). The mean number of ants collected from MaxForce treatment plots was not significantly different from controls ($P > 0.05$). Overall, the efficacy and residual studies suggested that the Advion/Top Choice combination produced both the most rapid reduction in ant foraging and the longest lasting control (90%) at 300 days. When evaluating time to knockdown of foraging populations, the Advion/Top Choice combination also provided the most complete and rapid results by day 7, reducing foraging by 100%. While other products also performed well (75.6 - 95.9% reductions), both the MaxForce and Advion plots had significant increases in foraging at 30-90 days. Overall, foraging knockdown was the most complete in the Avion/Top Choice combination plots at 90 days.

Introduction

Prior to 2009, all reported red imported fire ant (RIFA), *Solenopsis invicta* Buren, infestations in Virginia were documented and managed by the Virginia Department of Agriculture and Consumer Services (VDACS). In spite of VDACS' best efforts however, RIFA infestations within the state continued to increase and spread. Therefore, in 2009 the United States Department of Agriculture (USDA) in conjunction with VDACS implemented the Imported Fire Ant Quarantine in the following areas of Virginia: the counties of James City and York, and the cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg. Consequently, VDACS is no longer responsible for treating RIFA mounds in the quarantined areas. Fire ant control in the quarantined counties/cities is now the responsibility of homeowners, nurseryman, and pest management professionals. However, VDACS is still responsible for managing RIFA infestations in cities outside of the designated quarantine areas. As of 2014, the quarantine has not been expanded and VDACS is still responsible for controlling infestations in the large majority of the state.

The standard control method used by VDACS for treating RIFA mounds in Virginia in 2009 was to apply MaxForce® fire ant bait (1.0% hydramethylnon) (Bayer CropScience, Kansas City, MO) around each active mound. Bait applications were followed six weeks later by an acephate mound drench. Although effective, these individual mound treatments (IMT) required that all mounds be located prior to application and then treating them one at a time. While IMTs are labor intensive and time consuming, the direct chemical application to the mound does greatly enhance the amount of insecticide contact with colony members (Barr & Best, 1999).

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Baits and liquid insecticides are the typical formulations used for IMTs, but aerosols, granules, and dusts are also frequently used. IMTs are the most useful when 20 or fewer mounds are present in an acre of land (Barr & Best, 2002). IMTs are also beneficial because they are only applied specifically to RIFA mounds, thus preventing native ant mortality. However, because IMTs are only applied to visible mounds, fire ant recolonization can easily occur in treated areas where small mounds are overlooked and not treated. Multiple applications are often necessary to control all the mounds in a particular area.

In contrast to IMTs, broadcast insecticide treatments for RIFA do not require individual mounds to be located. Therefore, broadcast products greatly reduce the time and labor needed to treat a large area. Broadcast fire ant control products are currently formulated as either granules or baits and are applied using either a hand or tractor mounted spreader (Drees et al., 2006). Broadcast products are typically applied in locations where mound densities exceed 30-40 per hectare.

Bait formulations are frequently applied as a broadcast RIFA control method. RIFA baits are usually formulated by combining a slower acting toxicant with soybean oil or some other food matrix that is attractive to foraging fire ants (Williams et al., 2001). Once the ants transport the bait back inside the colony, the ants transfer the active ingredient throughout the colony by trophallaxis. Because the active ingredient must be spread throughout the colony via the worker ants feeding the queens and brood, it may take several weeks to months before significant colony reductions are observable in the field (Drees et al., 2006). Therefore, colony suppression may take significantly longer using broadcast baits when compared with IMTs that provide reductions in a single day. However, a study conducted by Barr and Best (1999) suggested that the benefits of large scale ant suppression that could be achieved with broadcast bait products far out-weighed the delay in short term (but eventual) results (Barr & Best, 1999).

Some broadcast fire ant products have been used to treat fire ants in Virginia, but they have been used infrequently due to VDACS' preference for individual mound treatments. However, now that VDACS is no longer responsible for treating infestations in quarantined counties and cities, residents in these locales have the burden of managing fire ants on their own. With the quarantine implementation, the need for broadcast RIFA product evaluations and other control recommendations are vital, if not for stopping RIFA, at least for slowing the spread of RIFA in Virginia.

Two of the leading broadcast fire ant control products are Advion® fire ant bait (Indoxacarb 0.045%; Syngenta, Research Triangle Park, NC) and Top Choice granular (Fipronil 0.143%; Bayer Environmental Sciences, Cary, North Carolina). Advion is a fast acting bait (Furman & Gold, 2006) that contains the active ingredient, indoxacarb, which belongs to the oxadiazine chemical class. Oxadiazines block sodium channels in the insect nerve axon. Immediately after bait ingestion, ant feeding begins to decrease and target individuals usually succumb to death within 48 hours (Barr, 2002a). Top Choice contains the active ingredient fipronil which belongs to the phenylpyrazole chemical class. Fipronil is a nerve poison that blocks the passage of chloride ions through GABA receptor and glutamate-gated chloride channels causing nerve hyperexcitation in target insects (Kolaczinski & Curtis 2001).

Previous studies have shown that Advion significantly reduced fire ant foraging 24 hours after treatment (Barr, 2004) and eliminated > 95% of colonies after one week (Hu & Song, 2007) after application. Top Choice has a longer residual activity than Advion but is much slower acting. Barr and Best (2004) reported that Top Choice® reduced the mean number of active fire ant mounds by 80% five weeks after treatment and greater than 90% control was observed 52 weeks later.

The purpose of this study was to evaluate the performance of specific broadcast Red Imported Fire ant treatment in Virginia, and compare their efficacy with that of an IMT. Our goal was to determine which application method might have the longest residual activity, and therefore the greatest potential to prevent fire ant spread. In this study, field applications of the RIFA control products: Advion® fire ant bait (Indoxacarb 0.045%; Syngenta, Research Triangle Park, NC); Top Choice granular (Fipronil 0.143%; Bayer Environmental Sciences, Cary, North Carolina); a combination application of Advion and Top Choice; and an IMT treatment using MaxForce® fire ant bait (1.0% hydramethylnon), were monitored for efficacy for one year. The following year, the same field applications were reapplied to determine the rapidity of initial knock-down.

Materials and Methods

Study Area

Although our initial research plots were established on an infested vacant lot in Hampton Roads, Virginia (2008; prior to the implementation of the Federal Fire Ant Quarantine (FFAQ), the research site came to the attention of a neighboring school facilities manager who demanded that VDACS treat the location. To avoid further conflict within Virginia we moved our research site 161 km due south to North Carolina where the entire state was already under the FFAQ. Our new research plots were established within Fun Junktion Park, a converted landfill located in Elizabeth City, NC. The study was conducted from 5 August 2008 to 26 July 2009. Elizabeth City is located on the northeast coast of North Carolina in Pasquotank County (36°17'44'N; 76°13'30'W). Average monthly temperatures range from a low of 0° C during the winter months to a high of 31.8° C during the summer months. The city receives about 122 centimeters of rainfall annually.

Research Plots

Fourteen 30 x 30 m (900 m^2) research plots (Fig 1a-b) were established within three different locations within the park.

Eight plots were located on a driving range that was covered with grass and mowed weekly. Four plots were established in a grass covered field located near an artificial lake. Two plots were located in a weed covered field that was not mowed. An untreated buffer zone (7.6 m) separated each plot to reduce potential ant foraging between research plots. Plots were randomly assigned to different treatments so that each of the four insecticide treatment had three replicates. The two remaining plots served as untreated controls.

A

B

Fig. 1a-b. Placement of 1-year RIFA treatment plots located at Fun Junktion Park, Elizabeth City, NC (Google Earth 2010)- Advion (**Adv**), Top Choice (**TC**), MaxForce (**MF**), Advion /Top Choice combination (**Com**) and untreated control (**Con**).

Treatment Products

The broadcast products evaluated in the study were Advion® Fire Ant Bait (0.045% indoxacarb; Syngenta, Research Triangle Park, NC), Top Choice® Insecticide (0.0143% fipronil; Bayer Environmental Science, Research Triangle Park, NC) and MaxForce® Fire Ant Killer Granular Bait (1.0% hydramethylnon; Bayer Crop Science, Kansas City, MO). Advion and Top Choice were also used in a combination treatment where they were applied together in the same plot. All broadcast products were applied at the label rate (Advion: 1.68 kg/hectare (1.5 lbs./acre), Top Choice: 209 kg/hectare (85 lbs./acre), MaxForce: 14-28g/ mound (0.5-1.0 oz./mound), Combination: Advion/Top Choice) using Scott's Handy Green II hand spreaders (Scotts International B.V., Scotts Professional, Geldermalsen, The Netherlands). The MaxForce bait is labelled for application as a broadcast or as an individual mound treatment. However, for the purposes of this study, MaxForce was used as an IMT and was applied directly to individual mounds from the product container. Treatment applications were made on 12 July 2008 between 5:00 p.m. and 7:00 p.m. Each broadcast treatment was applied to three plots. MaxForce bait was applied to seven active fire ant mounds located in three experimental plots.

Sampling Regimen to Quantify Foraging Activity

Prior to treatment applications, slices of uncooked hot dog wieners were used as baits to quantify foraging activity in each of the plots. Pre-treatment bait counts were taken on 11 July 2008 between 5 and 7:00 p.m. Eight beef hot dog (Gwaltney, Smithfield VA) slices (0.5 cm thick) were placed in each plot. The hot dog slices were arranged in two rows of four and each row was spaced 7 m apart. Hot dog slices were left in place for one hour, after which photographic images were taken of each slice with a Sony Cybershot digital camera (Sony Electronics Inc., San Diego, CA). All images were downloaded onto a computer so that the species and number of ants in each hot dog photograph could be counted and recorded. Post-treatment ant sampling with hot dog slices was conducted between 5:00 p.m. and 7:00 p.m. at 3, 7, 14, and 30 days after treatment and every month thereafter for one year. During the initial study, post-treatment data collected on 7, 14, 30, and 60 days were lost after the computer laptop holding that data was stolen. In addition, sampling was not conducted during the winter months (121 and 239 days after treatment) because of low temperatures that eliminated ant foraging.

Product Reapplication to Determine Time to Knockdown

After the one year completion of the study described above, all plots were sampled again (as previously described) to determine ant foraging activity. After determining that the ant pressure had rebounded and was still very high, all products were reapplied. Treatment applications were made on 21 July 2009 between 5:00 p.m. and 7:00 p.m. MaxForce bait was applied to 5 mounds. Control plots (2) were left untreated. Post-treatment sampling was conducted between 5:00 p.m. and 7:00 p.m. Sampling was conducted on days 3, 7, 14, 30, 60, and 90 after treatment to determine the time to knockdown for all treatment products and combinations.

Statistical Analysis

The mean number of foraging fire ants collected per treatment on each sampling date was calculated by adding the total number of ants foraging on all 8 hot dogs in each treatment plot, and dividing that total by number of plots per treatment. To determine if the treatment applications had any effect on the mean number of foraging ants, data were transformed (√(x +⅜)) (Zar 1984) and subjected to repeated-measures multivariate analysis of variance (MANOVA), with the post treatment date as the repeated measure. Repeated-measures MANOVA was also used to determine if the residual activities of each treatment were significantly ($P \leq 0.05$) different from one another.

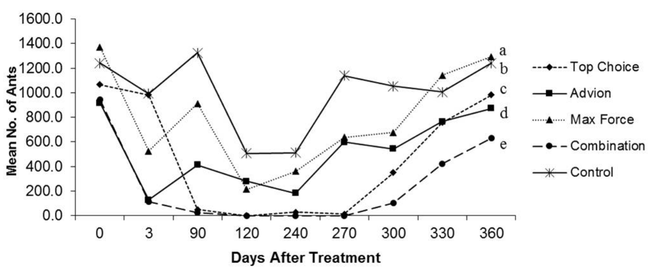

Fig 2. Mean number of foraging RIFA in experimental plots before and after product applications (one-year study). Trend lines followed by the same letter are not significantly different ($\alpha = 0.05$).

Differences in the mean number of RIFA collected in each treatment on each sampling date was determined using two by one way repeated-measures ANCOVA, with the mean number of foraging ants collected on DAT-0 as a covariate. Significant differences among treatment means on each post treatment sampling date were separated by Tukey's HSD test ($P \leq 0.05$). LS Means produced in the ANCOVA were used to calculate percent change in the mean number of RIFA foraging ants after treatment relative to the initial number of foragers on DAT-0 (Vickers 2001). Separate repeated-measures MANOVA and ANCOVA analyses were conducted on both the initial application (year-long test), and re-treatment (knockdown) data.

Results

Product Efficacy Tests

Repeated-measures MANOVA was used to determine whether product applications had any effect on the mean number of foraging ants collected in plots. Results of the repeated measures MANOVA indicated that there was a significant overall treatment effect on the mean number of foraging fire ants ($F = 72.0$; df = 9, $P < 0.0001$) (Figure 2). Contrast comparison tests between the mean number of foraging fire ants collected from treatment plots and control plots indicated that the mean number of foragers collected from each treatment plot was significantly lower ($P < 0.05$) than that collected in the controls. In addition, contrast comparison tests revealed that the mean number of ants collected in each of the treatment plots were all significantly different from each another.

The ANCOVA was conducted to compare the mean number of foraging ants in each treatment, on each sampling day. LS means calculated by the ANCOVA were used to calculate the percent change in the mean number of active foragers on each post treatment sampling date (Table 1). Three days after treatment the mean number of foraging fire ants in the Advion, MaxForce, and Advion/Top Choice combination plots was significantly lower than that in the untreated controls ($P < 0.05$). The greatest percent reduction in foraging three days after treatment was observed in Advion/Top Choice combination plots (82.7%) followed by Advion alone (79.5%), MaxForce (68.4%), and Top Choice alone (6.6%). Although sampling data was collected between for DAT-7 through DAT-60, these data were lost. When post-treatment sampling resumed on DAT-90 there were significantly fewer ants collected from the Advion (355.5), Top Choice (38.2), and Advion/Top Choice (0.0) plots than in the MaxForce (995.6) and control plots (1369.1). The greatest percent reduction in foraging at DAT-90 was observed in the Advion/Top Choice combination plots (100.0) followed by Top Choice (96.4), Advion (61.2), and MaxForce (27.5). For the remainder of the test (DAT-90 – DAT-360), fewer fire ants were collected in combination and Top Choice treatment plots than in all of the other experimental treatment plots. At the conclusion of the test on DAT-360, there were significantly fewer ants collected in Advion (777.7), Top Choice (972.8), and combination plots (596.2) than in the control plots (1257.8) (df 13, $F = 8.3$, $P < 0.05$). However, the mean number of ants collected from MaxForce treatment plots was not significantly different from controls ($P > 0.05$).

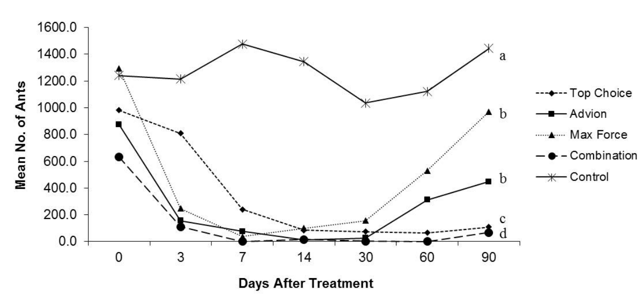

Fig 3. Mean number of foraging RIFA in experimental plots before and after product re-applications (90-day study). Trend lines followed by the same letter are not significantly different ($\alpha = 0.05$).

Overall, the results suggest that the Advion/Top Choice combination, and the Advion treated plots had the greatest reductions in ant foraging by day 3, causing foraging reductions of 82.7 and 79.5 percent respectively. However, Advion, Top Choice, and the Advion/Top Choice combination treatment also provided the longest lasting control with significant reductions in foraging at 360 days.

Table 1 Least square means (± SE) and mean percent change in number of foraging RIFA prior to and days after application.

	Day After Treatment (DAT)									
Treatment	DAT-0	DAT-3	DAT-90	DAT-120	DAT-240	DAT-270	DAT-300	DAT-330	DAT-360
Top Choice									
LS Mean (± SE)	1064.3	994.0^{a} (± 51.1)	38.2^{b} (± 108.7)	-3.3^{b} (± 56.7)	28.5^{c} (± 52.6)	8.7^{c} (± 63.8)	345.0^{bc} (± 101.2)	752.4^{b} (± 70.3)	972.8^{bc} (± 83.9)
Percent Change	-	(6.6)	(96.4)	(100.0)	(97.3)	(99.2)	(67.6)	(29.3)	(8.6)
Advion									
LS Mean (± SE)	916.7	188.1^{bc} (± 52.2)	355.5^{b} (± 111.1)	260.1^{ab} (± 58.0)	186.3^{bc} (± 53.7)	577.3^{b} (± 65.2)	510.2^{ab} (± 103.5)	734.3^{bc} (± 71.8)	777.7^{c} (± 85.8)
Percent Change	-	(79.5)	(61.2)	(71.6)	(79.7)	(37.0)	(44.3)	(19.9)	(15.2)
Max Force									
LS Mean (± SE)	1372.3	433.4^{b} (± 53.7)	995.6^{a} (± 114.3)	239.7^{ab} (± 59.6)	352.7^{ab} (± 55.3)	668.7^{b} (± 67.0)	723.6^{ab} (± 106.4)	1189.4^{a} (± 73.9)	1318.3^{ab} (± 88.2)
Percent Change	-	(68.4)	(27.5)	(82.5)	(74.3)	(51.3)	(47.3)	(13.3)	(3.9)
Advion/Top Choice Combinationo									
LS Mean (± SE)	944.0	63.3^{c} (± 51.9)	-24.4^{b} (± 110.4)	-15.2^{b} (± 57.6)	3.9^{c} (± 53.4)	-18.2^{c} (± 64.8)	78.0^{c} (± 102.8)	396.5^{c} (± 71.4)	596.2^{c} (± 85.2)
Percent Change	-	(82.7)	(100.0)	(100.0)	(99.6)	(100)	(91.7)	(58.0)	(36.8)
Untreated Control									
LS Mean (± SE)	1240.5	943.7^{a} (± 63.1)	1369.1^{a} (± 134.3)	519.6^{a} (± 70.0)	508.9^{a} (± 65.0)	1155.3^{a} (± 78.8)	1076.7^{a} (± 125.0)	1029.6^{ab} (± 86.8)	1257.8^{a} (± 103.7)
Percent Change	-	(23.9)	(10.4)	(58.1)	(59.0)	(6.9)	(13.2)	(17.0)	(1.4)
F	-	58.6	19.1	9.5	11.7	38.1	8.5	12.6	8.3
df	-	13	13	13	13	13	13	13	13
P	-	<0.0001	0.0003	0.003	0.001	<0.0001	0.0046	0.0013	0.005

Means within a column followed by the same letter are not significantly different (Tukeys HSD mean separation test; α = 0.05).

Product Reapplication to Determine Time to Knockdown

Repeated-measures MANOVA results indicated that the insecticide products had a significant overall treatment effect on the mean number of foraging fire ants ($F = 76.1$; df = 9, $P < 0.0001$) (Table 2). Contrast comparison tests between the mean number of foraging fire ants collected from insecticide treated plots and control plots indicated that the mean number of foragers collected from insecticide treated plots were significantly lower ($P < 0.05$) than that of the controls. Additionally, contrast comparisons also indicated that the greatest reductions in the number of active foragers occurred in the Advion (82.9%), MaxForce (79.6%), and Advion/Top Choice (85.7%) combination plots. These reductions were far greater than reductions observed in Top Choice (17.5%) and control plots (0.9%). The ANCOVA results indicated that throughout the test the mean number of ants collected in all chemical treatments was significantly lower ($P < 0.05$) than the mean number of ants collected in control plots on each sampling date. Additionally, from DAT-3 to DAT-30 the mean numbers of ants collected in chemical treatment plots were significantly lower ($P < 0.05$) than the mean number collected from the control plots. However, the mean number of ants collected from DAT-3 to DAT-30 in each of the treatments plots were not different from each other. However on DAT-60, the mean number of foraging ants increased in all plots except those treated with Top Choice.

While Advion and MaxForce still had significant reductions in foraging at day 60, the reductions were significantly less than those of Top Choice and the Advion/Top Choice combination at 60 days. At the conclusion of test on DAT-90, percent reductions in foraging were greatest in the Advion/Top Choice combination and Top Choice treated plots. At 90 days, the MaxForce bait had the lowest reduction in foraging, but this reduction was not significantly different from that in Advion or Advion/Top Choice combination plots. Overall, the knockdown of foragers was the most rapid and complete in the Advion/Top Choice treated plots on day 7 (100%). However all insecticide treatments produced between 90-100% knockdown in 7-14 days. The Advion/Top Choice combination and Top Choice treatments had the longest lasting effect, suppressing foraging by 89-93% for 90 days.

Discussion

Results obtained from the year-long field efficacy trial indicated that the Advion/Top. Choice combination treatment provided the both the most rapid control of fire ants and the greatest residual activity. While both products were very effective at controlling fire ants in the field, the Advion had most rapid activity although it did not suppress the populations as long as Top Choice. Top Choice did not produce the most rapid knockdown but did have the longest residual activity both alone and in the combination treatment (Table 1).

Table 2. Least square mean (± SE) and mean percent change of foraging RIFA prior to and after treatment reapplication.

	DAT (Days After Treatment)						
Treatment	DAT-0	DAT-3	DAT-7	DAT-14	DAT-30	DAT-60	DAT-90
Top Choice							
LS Mean (± SE)	972.8	809.0^{b} (± 64.4)	239.0^{b} (± 53.4)	83.0^{b} (± 46.0)	75.0^{b} (± 49.3)	68.3^{c} (± 46.7)	107.6^{c} (± 106.5)
Percent Change		(17.5)	(75.6)	(91.5)	(92.4)	(93.0)	(89.0)
Advion							
LS Mean (± SE)	777.7	149.1^{c} (± 70.0)	70.4^{b} (± 58.0)	-21.5^{b} (± 50.0)	39.2^{b} (± 53.5)	349.7^{b} (± 50.7)	441.4^{bc} (± 115.6)
Percent Change		(82.9)	(91.9)	(100)	(95.5)	(59.9)	(49.4)
Max Force							
LS Mean (± SE)	1318.3	264.2^{c} (± 97.7)	53.3^{b} (± 81.0)	187.0^{b} (± 69.7)	120.3^{b} (± 74.7)	429.7^{b} (± 70.7)	989.6^{ab} (± 161.4)
Percent Change		(79.6)	(95.9)	(85.5)	(90.7)	(66.8)	(23.5)
Advion/Top Choice Combination							
LS Mean (± SE)	596.2	90.2^{c} (± 106.7)	-18.5^{b} (± 88.5)	-85.1^{b} (± 76.1)	44.0^{b} (± 81.7)	116.5^{bc} (± 77.3)	44.3^{bc} (± 176.4)
Percent Change		(85.7)	(100)	(100)	(93.0)	(81.6)	(93.0)
Untreated Control							
LS Mean (± SE)	1257.8	1227.9^{a} (± 99.5)	1489.1^{a} (± 82.5)	1414.8^{a} (± 71.0)	1005.8^{a} (± 76.1)	1039.0^{a} (± 72.0)	1460.7^{a} (± 164.4)
Percent Change		(0.9)	20.1	14.1	(18.9)	(16.2)	17.8
F	-	36.7	79.5	91.3	45.5	59.0	20.3
Df	-	13	13	13	13	13	13
P	-	<0.0001	<0.0001	<0.0001	<0.001	<0.0001	0.0002

Means within a column followed by the same letter are not significantly different (Tukeys HSD mean separation test, α = 0.05).

Therefore it was no surprise that the two products combined produced results that were superior to either of the broadcast products used alone, and to the IMT using Maxforce bait.

In the 90 day knockdown evaluations, the Advion/Top Choice combination provided the most complete and rapid results by day 7, effectively reducing foraging by 100%. However, the other products also performed very well (75.6 - 95.9% reductions in foraging) and there were no significant differences between the treatments at 7 days (Table 2). Again at Day 14 all of the treatments were equally effective with both Advion and the Advion/Top Choice reducing RIFA foraging by 100%. Interestingly, the trend we observed over 30 to 90 days after application was that there was significant increase in RIFA foraging in both the MaxForce and Advion treatments, yet efficacy for the Top Choice alone and the Advion/Top Choice combination remained relatively high. Foraging suppression was significantly greater in the Avion/Top Choice combination at 90 days than in all other treatments. Overall, the advantage of the combined broadcast treatment application was that one formulation (Advion) was very fast acting, while the slower acting Top Choice provided the persistent residual activity that was limited in the Advion formulation. The data provided in these studies indicated that broadcast fire ant control products can provide longer residual control, and therefore that may slow the spread of RIFA colonies into untreated areas more effectively than IMTs (Williams et al. 2001, Banks et al. 1988). In both the residual study, and 90 day knock-down tests, Advion, Top Choice, and the Advion/Top Choice combination provided faster, longer lasting results than the MaxForce mound treatments.

Studies evaluating Advion conducted by Barr (2002a, 2002b) reported similar rapid knock-down results. In 2002, Barr conducted two tests, one in the summer and one in the fall to evaluate the efficacy of indoxacarb to control RIFA colonies. Both tests were conducted at an airport located in Yoakum, Texas. In both tests, Barr (2002a-b) compared the efficacies of different fire ant products: Amdro® fire ant bait (0.73% hydramethylnon; Ambrands, Atlanta, GA), Extinguish® fire ant bait (0.5% s-methoprene; Wellmark International, Schaumburg, IL), Talstar® 2G (0.2% bifenthrin; FMAC Professional Solutions, Philadelphia, PA) and three different concentrations of indoxacarb (0.025%, 0.05%, and 0.1%). Results from tests conducted in the summer (Barr 2002a) indicated that the three indoxacarb formulations provided faster control of RIFA colonies than the other RIFA products tested. One week after treatment, the mean number of active mounds in all of the indoxacarb treated plots ranged from (0.25 – 1.25) while the mean number of active mounds in plots treated with Amdro was 4.0; Extinguish 16.25, and Talstar was 3.25. However, 6 weeks after treatment the number of active colonies in all the indoxacarb treated plots began to increase. The number of active mounds found in the other treatment plots also began to increase, however fewer active colonies were documented in Extinguish treatment plots. Mound density in plots treated with indoxacarb continued to increase for the remainder of the test. Barr (2002b) replicated the airport test again in the fall, to determine if colony foraging or reproductive status influenced his summer results. Barr (2002b) found that in the fall the product efficacy results were similar to those of the previous summer. Overall, the three indoxacarb formulations provided more rapid foraging reductions than the other fire ant control products tested.

Similarly, studies evaluating Top Choice also found that the product provided longer residual fire ant control than other fire and products tested. Barr and Best (2004) conducted a test to evaluate the efficacy of two granular formulations of fipronil (0.0143%; 0.00015% fipronil) Amdro Ant Bait (0.73% hydramethylnon,Ambrands, Atlanta, GA), and Talstar 2G (0.2% bifenthrin, FMC, Philadelphia, PA). The study results demonstrated that fipronil provided greater long-term control than the other fire ant control products. Five weeks after treatment, granular applications of 0.0143% fipronil still provided an 83% - 98% reduction in the number of active mounds. By week 52 the number of active mounds began to rebound in all treatment plots except those treated with the fipronil (granular 0.0143%; Barr & Best, 2004).

Because the combination treatment used in our tests consisted of Advion (one of the fastest acting baits on the market) and Top Choice, (which provides long residual control) we expected the combination treatment to outperform the other products and provide long lasting control. Our results indicated that our expectations were correct. However, it should be noted that these products are most efficiently used in large scale situations where many mounds are present, and fire ant spread is a concern. Broadcast products are relatively expensive, costing $7-10 per hectare. Product costs for individual mound treatments are ~25 cents per mound, not including the labor (Drees et al., 2006). Therefore, for small infestations in a residential yard or in some other more contained area, individual mound treatments would still be the most desirable and effective method of fire ant management.

Conclusions

The overall results of this study determined that broadcast fire ant control products tested were faster acting and had a longer residual than The IMT. Presently, VDACS manages fire ant infestations outside of Virginia's fire ant quarantined areas while homeowners and pest control operators are responsible for treating infestations within quarantine borders. VDACS currently uses IMTs to treat all fire ant mounds outside of the quarantine area. Given the evidence provided in this study, it is reasonable to assume that in confined locations where all active fire ant mounds are visible, the IMTs will provide adequate control. However, in large areas that contain many mounds, like a vacant lot, a broadcast application can provide better and longer lasting control. As proven by the implementation of the RIFA Quarantine, the IMT method used alone was not enough to slow the spread of the Red Imported

Fire ant in Virginia. While broadcast RIFA products are more expensive than IMTs they require very little labor to apply. Thus government agencies like, VDACS could possibly save money on the application costs outside the quarantine area by adding broadcast application products to their RIFA arsenal.

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