Use of Cruiser Maxx® Rice Seed Treatment to Improve Tolerance of Conventional Rice to Newpath (Imazethapyr) and Roundup (Glyphosate) at Reduced Rates Over 2 Years

R.C. Scott, G. Lorenz, J.T. Hardke, J.K. Norsworthy, and B.M. Davis

ABSTRACT

A field trial was conducted in 2013 and again in 2014 to evaluate the effect of the insecticide seed treatment Cruiser Maxx Rice on exposure of young conventional rice (Roy J) to the herbicides glyphosate (Roundup) and imazethapyr (Newpath). Rice seed was treated with 7 oz/100 lb of Cruiser Maxx Rice which contains thiamethoxam insecticide, a neonicotinoid class of insecticide, plus a fungicide mixture (treated seed) and compared to seed that was treated with the same components minus the thiamethoxam (untreated). Rice plants from seed treated with Cruiser Maxx Rice were able to tolerate significant amounts of both imazethapyr and glyphosate in comparison to rice of untreated seed receiving the same herbicide treatments. Newpath rates evaluated were 1.0, 0.5 and 0.25 oz/acre; Roundup PowerMax (hereafter Roundup) rates evaluated were 4.0, 2.0, and 1.0 fl oz/acre. Treatments were applied to 3-lf rice. When averaged over 2 years, Newpath applied at 0.5 fl oz/acre caused over 30% more visible injury at 42 days after treatment and resulted in a 100 bu/acre yield decrease in 2013 and a 30 bu/acre reduction in 2014 for rice from nontreated seed compared to rice from seed treated with Cruiser Maxx Rice. Similarly rice from seed treated with Cruiser Maxx Rice and then exposed to 4 fl oz/acre of Roundup yielded 70 (2013) and 20 (2014) bu/acre more than the rice from nontreated seed. Positive effects of the seed treatments were seen in days to heading, canopy height, yield, and visible injury at all rates evaluated in 2013 and to a lesser extent in 2014.

INTRODUCTION

Currently, approximately 50% of the rice grown in Arkansas is Clearfield rice and receives applications of the herbicides Newpath (imazethapyr) or Beyond (imazamox)
(Hardke and Wilson, 2012; Wilson et al., 2010). The other 50% of rice grown in the state lacks the Clearfield tolerance trait and is therefore susceptible to injury if Newpath or Beyond is somehow applied to the field either through tank-contamination, drift, or by accidental application. In addition, there are over 3 million acres of soybean grown in Arkansas in close proximity to rice. The majority of these soybean acres are Roundup Ready and receive applications of the herbicide Roundup (glyphosate). Previous research has shown that both Newpath and Roundup can be harmful to rice yields depending on rate and timing of exposure (Davis et al., 2011; Hensley et al., 2012).

In previous research, York et al. (1991) found that disulfoton and phorate greatly reduced clomazone injury to cotton when applied in-furrow. Similar results with the in-furrow applications of phorate were also documented; however not of the insecticide aldicarb in 1990 and 1991 (York and Jordan, 1992). Both these reductions in crop injury were observed in the relative absence of insect pressure. This effect was later quantified in the lab by Culpepper et al. (2001). They determined that this “safening effect” was due to the insecticide causing a change in the metabolism of clomazone in cotton, suggesting that some clomazone metabolite may be more toxic to cotton than the compound itself. Nonetheless, this work does represent a precedent for using a soil or in-furrow insecticide treatment to “safen” a crop to a given herbicide. In fact, this was a common practice throughout the mid to late 1990s and early 2000s in cotton production prior to the introduction of Roundup Ready™ Cotton (Culpepper et al., 2001).

Wilf et al. (2010) and later Plummer et al. (2012) have documented many benefits of soil insecticide treatments in rice. Some of these benefits include overall improved plant vigor that may or may not be due to insect pressure but to other biological processes inside young rice seedlings as they are affected by the presence of the insecticide. In 2011, an observation was made by Gus Lorenz, State Extension Entomologist, University of Arkansas, that some of his insecticide treated rice was able to tolerate an accidental herbicide drift from an adjacent field (pers. comm.). The ability to safen rice to potential herbicide drift or injury from other herbicides would be a valuable tool for rice producers today. This seems to be especially true as seeding rates are lowered for many rice varieties and hybrids. In 2013, an initial study indicated that the use of CruiserMax rice seed treatment could prevent some crop response from low doses of both Newpath and glyphosate herbicides (Dickson et al., 2014).

The objective of this research was to confirm across years the potential for Cruiser Maxx Rice insecticide seed treatment to protect conventional rice (Roy J) from both Newpath and Roundup exposure.

**PROCEDURES**

This experiment was conducted at the University of Arkansas at Pine Bluff Research Farm located just north of Lonoke, Ark., in the summers of 2013 and 2014. The soil texture is a silt loam with a pH of 6.3. Conventional rice (Roy J) was seeded on 31 April 2013 and on 20 May 2014 with a Hege cone-drill calibrated to deliver a seeding rate of 90 lb/acre on 7.5-inch-spaced rows. Plot size was 5 ft × 25 ft. The study was conducted with a randomized complete block design having four replications.
Treatments consisted of seed treatment and herbicide combinations. The seed treatments consisted of a “treated seed” on which Cruiser Maxx Rice at 7 oz/100 lb of seed was applied. Cruiser Maxx Rice contains 26.4% thiamethoxam, 1.65% mefenoxam, 1.32% azoxystrobin, and 0.28% fludioxonil. The second seed treatment was considered the “nontreated seed” which actually was seed treated with the equivalent amounts of azoxystrobin, mefenoxam, and fludioxonil minus the insecticide thiamethoxam.

The herbicide treatments were applied at the 2- to 3-ft growth stage of rice with a CO₂ backpack sprayer calibrated to deliver 10 gallons of spray solution per acre. Herbicide treatments included Roundup PowerMax (5.5 lb ai/gal formulation) applied at 0, 1, 2, and 4.0 fl oz product/acre and Newpath 2AS (2 lb ai/gal formulation) applied at 0, 0.25, 0.5 and 1.0 fl oz product/acre. The plot area was maintained weed free with conventional rice herbicides, and the rice was grown according to University of Arkansas System Division of Agriculture's Cooperative Extension Service recommendations for soil fertility.

Data collected included percent visible injury at 7, 21, and 42 days after treatment (DAT) on a scale of 0 to 100 with 0 being no injury and 100 being complete crop death; canopy heights at 68 DAT using a yard stick and a 1 meter square piece of cardboard as described by Davis et al. (2011), percent rice heading at 107 DAT, and percent moisture and grain yield at harvest. Data were analyzed and Fisher’s least significant difference test was performed at $P = 0.05$ level of significance using Agricultural Research Manager (ARM) v. 9.1.4 (Gylling Data Management, Inc., Brookings, S.D.).

**RESULTS AND DISCUSSION**

As early as 7 DAT, both Newpath and Roundup were causing visible injury to rice (Table 1). Plants grown from the nontreated rice seed were injured by Roundup from 15% to 25% and from treated seed 11% to 17% depending on rate. Newpath at 7 DAT also caused injury ranging from 5% to 24% depending on rate and whether the seed was treated or not. Injury from Newpath was already visibly less on rice plants with the seed treatment 7 DAT, especially at 0.50 and 0.25 fl oz/acre, where rice was injured nine to ten percentage points less when seed was treated with the insecticide thiamethoxam averaged over 2 years. Injury symptoms included stunting and chlorosis (yellowing).

By 21 DAT, injury symptoms had become more pronounced for all Newpath treatments. Rice plants from treated and nontreated seed were injured over 50% by Newpath at 1.0 fl oz/acre. However, some differences were also becoming more pronounced by 21 DAT. For example, where Newpath at 0.5 fl oz/acre was applied to rice plants grown from nontreated seed it injured rice 36% versus only 13% for treated seed. Roundup at 4 fl oz/acre injured rice with treated seed 12 percentage points less than when seed was nontreated.

In 2014, rice injury was reduced to less than 10% for all treatments (data not shown). However in 2013, injury had been equal for Newpath applied at 1 fl oz/acre to rice from both treated and nontreated seed at 21 DAT. In 2013, rice plants from treated seed had recovered by 42 DAT and injury for treated versus nontreated was 58% and
97%, respectively (Table 1). Other herbicide seed treatment interactions were even more pronounced at 42 DAT. Newpath applied at 0.25 fl oz/acre caused no visible injury to rice with treated seed; whereas, 26% injury was observed in nontreated rice. Injury from this rate of Newpath to plants grown from nontreated rice seed was consistently rated at 25% for the duration of the test. At 0.5 fl oz/acre rate of Newpath, injury to rice grown from the treated seed had dropped to 6%, versus 63% for rice where the seed was nontreated. Roundup applied at 4 fl oz/acre resulted in 53% injury to the rice plants with the nontreated seed versus only 10% when rice seed was treated. The later planting date and warmer, sunnier growing conditions in 2014 versus 2013 may account for differences in rice recovery between years.

Canopy heights were not affected by any treatments in 2014 (data not shown). Treatment differences were observed in canopy height taken at 68 DAT in 2013 (Table 1). Rice plants that did not receive any herbicide treatment, regardless of seed treatment grew to a canopy height of 35 inches. Newpath reduced canopy height at the 0.5 and 1.0 fl oz/acre rates when applied to rice with non-insecticide treated seed. There were not enough rice plants in the 1.0 fl oz/acre Newpath treatment to get a canopy height due to severe stand reduction in the absence of the insecticide seed treatment. However, the rice with treated seed survived the 1.0 fl oz/acre of Newpath and resulted in a canopy height of 30 inches, not statistically different from the check (35 inches).

Roundup in general did not affect canopy height as severely as Newpath (Table 1). Both insecticide treated and nontreated rice seed produced plants with canopy heights from 32 to 38 inches when 1 or 2 fl oz/acre of Roundup were applied with no statistical difference from the nontreated check. However at the 4 fl oz/acre rate of Roundup, the rice with nontreated seed grew to 23 inches while the rice with treated seed reached a normal height similar to the check of 36 inches by 68 DAT.

Percent heading, harvest moisture, and grain yield were obtained at 107 DAT in both years of this study. However no significant differences in heading or moisture were observed in 2014 (data not shown). For purposes of this study, a common harvest date was selected to simulate a decision that a grower might have to make as to when to harvest a field with varying degrees of injury. For this reason the above mentioned harvest parameters might have been slightly different if, for example, some of the more severely injured rice was given more time to mature and dry down. Likewise, the less injured rice could have been harvested sooner. However, due to study design this was not practical. Therefore, a single harvest date was chosen based on a time when the majority of rice was mature. In 2014, almost all treatments resulted in a uniform maturity and harvest date; one possible exception was the 1 fl oz/acre rate of Newpath on nontreated rice. This difference was evident only in the grain yield results.

Percent heading was taken as a visual rating based on the non-herbicide treated checks which were both 100% headed at 107 DAT in 2013 (Table 1). The only rice that received an insecticide seed treatment and had delayed heading was when 1 fl oz/acre Newpath was applied which reduced heading about 40% compared to the check. All rice that received the insecticide thiamethoxam in the seed treatment resulted in 95% to 100% heading at the time evaluated. Newpath generally delayed heading or prevented heading to a more severe degree than Roundup on nontreated seed plants. Newpath at
0.25, 0.5, and 1 fl oz/acre resulted in 20%, 42%, and 52% reductions in rice heading, respectively, at 107 DAT on rice grown from nontreated seed.

At harvest, grain yield and percent moisture was determined for each treatment. There was a tremendous amount of variation among the herbicide treated rice which resulted in few statistical differences. The non-herbicide treated checks were at 22% moisture at harvest time in 2013 (data not shown). With a least significant difference of 8% moisture, few of the treatment differences were significant. Results like these can be common when dealing with rates of herbicides applied far below the labeled rates (Davis et al., 2011; Hensley et al., 2012). Again in 2014, harvest and maturity of all treatments were much more uniform than in 2013.

Due to a significant interaction between years, yield results are presented by year (Table 1). In 2013, grain yield of rice ranged from 17 to 170 bu/acre with a least significant difference (0.05) of 25 bu/acre for this experiment. Rice plants grown with non-treated rice seed and no herbicide yielded 147 bu/acre while the insecticide treated check yielded 169 bu/acre. When Newpath herbicide was applied at either 0.25 or 0.5 fl oz/acre to rice grown from seed treated with thiamethoxam resulting yields were ~100 bu/acre higher compared to rice grown with nontreated or fungicide-only treated seed. However, at the 1 fl oz/acre rate of Newpath even the rice with treated seed yielded only 45 bu/acre compared to 17 bu/acre for rice with non-treated seed. These results suggest that there is a limit to thiamethoxam’s ability to “safen” rice to Newpath. In 2013, all treatments with insecticide treated rice seed yielded higher than non-treated rice seed when exposed to Roundup (Table 1). This difference was most pronounced at the 4 fl oz/acre rate of Roundup where yield was improved by 69 bu/acre with the addition of a seed treatment that included thiamethoxam.

No major differences in yield were observed in 2014 (Table 1). However, rice grown from nontreated seed yielded 194 bu/acre when Newpath was applied at 1.0 fl oz/acre and 197 bu/acre when 0.5 fl oz/acre of Newpath was applied. The treated-seed check yielded significantly higher at 231 bu/acre.

**SIGNIFICANCE OF FINDINGS**

The ability of a seed treatment to enable young rice plants to better tolerate off-target drift of both Newpath and Roundup could significantly reduce the number of complaint investigations requested by growers to both the Arkansas State Plant Board and the Cooperative Extension Service. The resulting higher yields (2013) as rice injury was reduced are not only a benefit to growers, but also to those responsible for the off-target movement. This research does confirm the results observed in 2013 even though the response to the seed treatment was not as great in 2014. Although more research is needed, the potential ability of an insecticide seed treatment to improve tolerance of certain Clearfield hybrid varieties such as XL745 would be of benefit under cool, wet conditions especially with reduced seeding rates. Approximately 50% of rice grown in Arkansas is Clearfield. Findings from this research could enable growing Clearfield and non-Clearfield varieties in closer proximity to each other more plausible and less
troublesome to applicators and growers. Other applications of this new discovery are currently being evaluated.

**ACKNOWLEDGMENTS**

Special appreciation is extended to the Rice Research and Promotion Board for providing funding and support for this project.

**LITERATURE CITED**


Table 1. Effect of Newpath and Roundup at reduced rates on rice injury, plant canopy height, heading date, percent grain moisture and yield when applied to insecticide treated versus untreated Roy J rice seed at the University of Arkansas at Pine Bluff Farm, near Lonoke, Ark., in 2013 and 2014, averaged across years when possible ($P = 0.05$).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Herbicide rate (fl oz/acre)</th>
<th>Visible injury</th>
<th>Height 2013</th>
<th>Heading 2013</th>
<th>Grain yield 2013</th>
<th>Grain yield 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2013-14 7DAT</td>
<td>2013-14 21DAT</td>
<td>2013 42DAT</td>
<td>68DAT</td>
<td>107DAT</td>
</tr>
<tr>
<td>Treated</td>
<td></td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(in.)</td>
<td>(%)</td>
</tr>
<tr>
<td>Nontreated</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>35</td>
<td>100</td>
</tr>
<tr>
<td>Newpath</td>
<td>0.25</td>
<td>15</td>
<td>16</td>
<td>26</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>Treated</td>
<td>0.25</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>36</td>
<td>100</td>
</tr>
<tr>
<td>Newpath</td>
<td>0.50</td>
<td>24</td>
<td>36</td>
<td>63</td>
<td>21</td>
<td>58</td>
</tr>
<tr>
<td>Treated</td>
<td>0.50</td>
<td>16</td>
<td>13</td>
<td>6</td>
<td>32</td>
<td>95</td>
</tr>
<tr>
<td>Newpath</td>
<td>1.0</td>
<td>24</td>
<td>61</td>
<td>97</td>
<td>--</td>
<td>48</td>
</tr>
<tr>
<td>Treated</td>
<td>1.0</td>
<td>17</td>
<td>51</td>
<td>58</td>
<td>30</td>
<td>63</td>
</tr>
<tr>
<td>Newpath</td>
<td>1.0</td>
<td>17</td>
<td>15</td>
<td>13</td>
<td>38</td>
<td>83</td>
</tr>
<tr>
<td>Treated</td>
<td>1.0</td>
<td>12</td>
<td>13</td>
<td>0</td>
<td>35</td>
<td>98</td>
</tr>
<tr>
<td>Roundup</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated</td>
<td>2.0</td>
<td>15</td>
<td>17</td>
<td>11</td>
<td>32</td>
<td>90</td>
</tr>
<tr>
<td>Roundup</td>
<td>2.0</td>
<td>11</td>
<td>9</td>
<td>0</td>
<td>34</td>
<td>95</td>
</tr>
<tr>
<td>Treated</td>
<td>4.0</td>
<td>25</td>
<td>28</td>
<td>53</td>
<td>23</td>
<td>78</td>
</tr>
<tr>
<td>Roundup</td>
<td>4.0</td>
<td>25</td>
<td>16</td>
<td>10</td>
<td>36</td>
<td>95</td>
</tr>
<tr>
<td>LSD ($P = 0.05$)</td>
<td></td>
<td>8</td>
<td>10</td>
<td>21</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>