

INFLUENCE OF RICE PRODUCTION ON THE QUALITY
OF WATER IN TAILWATER COLLECTION RESERVOIRS

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Research Project Technical Completion Report

The research on which this report is based was financed in part by the United States Department of the Interior as authorized by the Water Research and Development Act of 1984 (P.L. 98-242).

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Fayetteville, Arkansas 72701

July 1, 1995 June 30, 1996

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ABSTRACT

Since maintaining high water quality standards in the state remains a high priority, monitoring for pesticides in water sources must continue. Determining the type, concentration, and characteristics of any pesticides present in water supplies are essential to the overall assessment of water quality.

Five independent locations, implementing contained water management systems and recyclable water, were monitored in 1995 and 1996. Irrigation, runoff, and pond water samples were collected every 10 to 14 days between permanent flood establishment and draining. Water samples were transported to the laboratory and extracted for 16 pesticides using solid phase extraction (SPE) techniques. Quantification and confirmation of pesticide residues were obtained by HPLC and GC/MS analysis. The lower limit of quantitation for all pesticides was between 1.0 - 1.3 $\mu\text{g L}^{-1}$ in water. Pesticides selected for monitoring were determined after assessing state recommendations and our analytical capabilities. Pesticides included: benomyl, bensulfuron methyl, carbaryl, carbofuran, 2,4-D, fenoxaprop ethyl, propiconazole, malathion, MCPA, methyl parathion, molinate, pendimethalin, propanil, iprodione, quinclorac, triclopyr, and thiobencarb.

Since each field location was independently managed, individual results are site specific. 2,4-D, benomyl, molinate, propanil, quinclorac, thiobencarb, and pendimethalin were the pesticides actually applied during the seasons. These pesticides were detected, usually at trace levels, in tailwaters shortly after application but did not appear to buildup in the reservoirs. Quinclorac residues in the tailwaters were more persistent (up to 8 weeks) than the other detected compounds (less than 2 weeks).

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ACKNOWLEDGMENTS

The authors would like to acknowledge the cooperation of all our cooperators for allowing us to collect water samples from their production systems. The financial support from Arkansas Water Resources and the Arkansas Rice Research and Promotion Board is also appreciated.

INTRODUCTION

Arkansas rice producers, like many others, rely on manmade pesticides and fertilizers to achieve optimum yields. Since rice is produced under flooded soil conditions, and pesticides and fertilizers are often applied directly to the water, their residual time in tailwaters is very important. Since these materials have the potential for impacting water quality both at nearby outlets and much further downstream, it is important that Arkansas conduct research to help maintain our high quality water supplies while continuing to be the leading rice producing state in the nation.

In recent years, both public awareness and concern about water quality have increased. Reported findings of numerous pesticides in water supplies have caused some agricultural production systems to be questioned. Although many of these reports involve corn and soybean pesticides, it is important to note, that inputs from several other agricultural systems have the potential to adversely affect the environment. Detections of both molinate and thiobencarb residues in the Sacramento River have resulted in restrictions for California rice producers, which now require them to hold the flood waters on site for several days prior to its release (Ross and Sava, 1986). Closer to Arkansas, molinate and thiobencarb residues have also been detected in the Mississippi River and its tributaries (Pereira and Hostettler, 1993). With current methods and analytical capabilities, trace level

detections of pesticides in water are not unusual, especially in regions of intense agricultural production (Cast, 1994). The difficulty though, rests in assessing the significance of trace level detections. Although pesticide risk assessment involves many assumptions and is not an exact science, it is essential to continue monitoring the environment to aid in determining any potential problems before they become severe.

OBJECTIVE

The overall objective of this research is to assess pesticide runoff in tailwaters from rice fields and determine pesticide fate in retaining ponds.

RELATED RESEARCH

Assessing water quality for pesticide and nutrient content is a very complex process. However, it has recently been gaining interest in our society. Many factors are involved in determining water quality, and agriculture is just one of the many variables. Agricultural scientists are concerned about water quality just like everybody else. In December 1992, CAST produced a task force report entitled Water Quality: Agriculture's Role to address some of the agricultural issues. Additionally, the July-September, 1993 issue of the Journal of Environmental Quality devotes 130 pages (pp 389-518) to water quality. These pages are filled with manuscripts from the USDA-ARS Beltsville Agricultural Research Center Symposium XVII, "Agricultural Water Quality Priorities, a Team Approach to Conserving Natural Resources." In April 1994, CAST released an issue paper entitled "Pesticides in Surface and Ground Water." This paper addresses the fact that pesticides have been detected in water supplies and gives some insight on how to interpret the findings. This shows that there is concern among agricultural

researchers about water quality and how agriculture impacts it.

As with the overall topic of water quality, the impact of agriculture on the world's water supply is very complex. Therefore, the issue should be divided and subdivided many times in order to concentrate on individual topics of interest. Combining the fact that Arkansas is a leading producer of rice in the United States with the practice of pesticide application into flooded rice culture provides a timely topic of significant research interest to many parties, including the producers, regulators, environmental groups, and the consumers.

Several studies have been conducted where investigators have monitored for pesticide residues in creeks and rivers (Cooper et al., 1987; Pereira and Rostad, 1990; Pereira and Hostettler, 1993). Low levels of many pesticides were found in the Bear Creek, Mississippi (Cooper, et al., 1987) and the Mississippi River (Pereira and Rostad, 1990; Pereira and Hostettler, 1993) with the largest concentrations corresponding to heavy rainfall periods. The final destination of these pesticides is the Gulf of Mexico, but the environmental effects of these low concentrations on such a large body of water are difficult to assess and not well understood (Pereira and Rostad, 1990). Many factors are involved in determining the distribution and fate of pesticides in the Mississippi River and can be applied to all surface water sources. These factors include biogeochemical properties of pesticides, geographic location of crop type and amount and time of pesticide application, soil type and sorptive capacity, tillage practice, and variations in climatic, seasonal, and hydrologic conditions (Pereira and Hostettler, 1993).

The fact that low concentrations of pesticides exist in surface waters is reason for concern. However, it is difficult to cure this problem since the pesticides are already there. The focus of concern needs to be prior to incorporation into the water supply. Therefore,

runoff from the field should be studied more thoroughly.

Recent studies from our laboratory suggest that persistence of several pesticides used in rice production may not be contributing significantly to impaired water quality (Johnson et al., 1993). Trace levels of thiobencarb were detected in paddy water 0 and 1 day after flood establishment. 2,4-D and triclopyr concentrations in paddy water were at or below levels of detection by 28 days after application. Carbofuran and molinate concentrations dissipated rapidly from water, but trace levels of molinate were still detectable through 49 days. These new findings require thorough investigation in commercial rice producing systems.

This is a good place to start, but should not be the lone source of information. First of all, the variability of pesticide concentrations in agricultural runoff can be quite large during a single runoff event. Secondly, there is a complex combination of factors involved after water leaves the edge of the field. Some of these factors are dilution by the receiving water source, pesticide adsorption by stream sediments or vegetative surfaces, etc. (Wauchope, 1978). Therefore, additional information such as ability of local ecosystems to overcome fluctuating pesticide concentrations and pesticide dissipation processes from aquatic conditions must be investigated to relate pesticides in runoff to overall water quality (Wauchope, 1978).

Even though edge of field runoff is not the ultimate measurement, it is presently the best source we have for predicting potential problems with water quality. In order to improve the ability of predicting these potential problems, a semi-empirical formula emphasizing the physical chemical properties of the pesticide, location of spray deposits, amounts applied, and dissipation and degradation of spray deposits before runoff occurs was developed (Wauchope and Leonard, 1980). This is still a crude method of predicting losses in runoff, but

can give an estimate within one order of magnitude.

Pesticide dissipation processes under aquatic conditions are not routinely evaluated in most pesticide research. However, since rice is produced under flooded conditions, information from studies on pesticide dissipation from flooded rice culture can help predict how other pesticides may behave in our water resources. To date, the majority of the research has been conducted in California (Ross and Sava, 1986; Ross et al., 1989; Soderquist et al., 1977) and Texas (Deuel et al., 1977; Deuel et al., 1978; Deuel et al., 1979).

Propanil, the most common rice pesticide applied for weed control, has been found to dissipate completely from flood water within 24 hours following flooding (Deuel et al., 1977). Another herbicide, molinate, has been studied by several investigators. Early studies found molinate persistence in water to range from 3 to >10 days depending on application method (Tanji et al., 1974). Volatilization from water has been noted as the primary dissipation path for molinate with some photodecomposition occurring also (Soderquist et al., 1977). Detections of molinate and 4-ketomolinate (a photo oxidation byproduct) at various locations in the lower Mississippi River indicate that photodecomposition of molinate probably occurs in the field, but not in the river (Pereira and Hostettler, 1993). This was concluded based on relatively constant ratios of parent material to byproduct being found in the water samples. Molinate dissipation from small scale field plots in Texas was investigated under two irrigation schemes. Half-lives under intermittent irrigation were 96 ± 22 hours while under continuous flow irrigation, they were determined to be 54 ± 17 hours (Deuel et al., 1978).

In California, the detection of rice pesticides in surface waters resulted in restrictions requiring producers to hold their flood waters on site for several days prior to releasing the water into the typical

agricultural drains in hopes of promoting additional dissipation. This holding system was determined to be effective in promoting dissipation of molinate, but ineffective for thiobencarb dissipation (Ross and Sava, 1986). These results were attributed to the varying properties of the pesticides and gave differing distributions in mass balance equations. Thiobencarb is less volatile, less soluble in water, and more strongly adsorbed to soil than molinate and was primarily distributed between water (34%) and soil (43%) with <1% found in air and vegetation. Molinate, in comparison, was distributed as follows: 81% in water, 10% in air, 9% in soil, and <1% in vegetation.

A few other pesticides have been studied under flooded rice culture also. Carbofuran, an insecticide, was found to generally dissipate within 96 hours following application into plot water (Deuel et al., 1979). Dissipation was suggested to occur through an adsorptive mechanism in the water. Another herbicide, bentazon, was found to require between 11 and 32 days for a 50% reduction in water (Ross et al., 1989).

Somewhat conflicting results have been found in Italy (Cabras et al., 1983). In these studies, bentazon, 2,4-D, propanil, and molinate residues were all determined to be below the limit of determination of 0.03 mg kg⁻¹. This data is not directly related to the other information presented due to differences in cultural practices.

Technology advances in solid phase extraction (SPE) will aid in rapid and efficient extraction of water samples (Hearne and Hall, 1993; Senseman et al., 1993). Development of SPE disks gives several advantages over the previously used SPE columns. Elimination of channeling, reduced column-conditioning requirements, and ability to extract larger sample volumes are just a few. SPE disks have been found to be stable media for pesticide storage (Senseman et al., 1993) which could reduce the need to store large numbers of awkward glass bottles.

This could lead to the development of a field extraction device and allow transporting disks from the field to the lab instead of bottles of water.

As stated before, presently there is no peer-reviewed, published literature on this subject involving Arkansas rice production practices. A member of our research group is currently looking at a similar topic with small-scale field plots (Johnson et al., 1993). We intend to expand that information by taking his results and applying them to large scale commercial rice production.

The fact that pesticide residues have been found in water sources is reason for concern. However, many of the reported findings, obtained using highly sensitive analytical methods, are of very low concentrations (sometimes sub ppb range). This leads to confusion in interpretation due to the practice of pesticide risk assessment. The ultimate goal of the researcher is to provide an accurate determination of the amount of material present and then appropriately assess any health risk associated with that finding (CAST, 1994). Several assumptions must be made with this assessment and therefore the overall procedure is not an exact science. It is essential that exposure and toxicity be considered in determining any risk. Analysis of a water sample for pesticide residues is only one component of the overall system and additional data must be collected.

Often, detecting pesticide residues in water is difficult because of the sampling approach. A typical approach is to collect 1 L grab samples for analysis. Concentrations of some pesticides in this type of sample may be below the lower limits of detection. Therefore, catfish have been used to serve as a bioaccumulating species of certain organic pesticides (Leiker et al., 1991). This technique would give a better indication of the effect of long-term exposure to low level pesticide concentrations than solely trying to interpret the findings from a grab

sample.

MATERIALS AND METHODS

Five sampling locations were established utilizing water management systems with the potential to pump and recycle rice irrigation water from confined reservoirs that collect tailwater drainage from the field. Tailwaters, pond, and irrigation water samples were collected on a bimonthly schedule which began with the permanent flood establishment. Water samples (900 mL) were transported, on ice, from the sampling locations to the Altheimer Laboratory for extraction and analysis. At the time of sample collection, field fortified solutions were also prepared from each location to monitor the stability of the selected pesticides in water during transport. Based on state recommendations and our analytical capabilities, the following sixteen pesticides were selected for analysis: benomyl, bensulfuron methyl, carbaryl, carbofuran, 2,4-D, fenoxaprop ethyl, propiconazole, malathion, MCPA, methyl parathion, molinate, pendimethalin, propanil, iprodione, quinclorac, triclopyr, and thiobencarb. From this screening list, benomyl, 2,4-D, molinate, propanil, quinclorac, thiobencarb, and pendimethalin were actually applied at one or more locations during 1995 or 1996. All samples were prefiltered through Whatman GF/F filter paper (0.7 μ m particle retention) to remove any suspended sediment. Filtered water (250 mL) was extracted using a 47-mm vacuum extraction manifold equipped with Empore C-18 extraction disks. Analytes were eluted with ethyl acetate and concentrated to the desired volume under a stream of dry nitrogen. An aliquot of the final extract was evaporated to dryness and resuspended in acetonitrile/water for high performance liquid chromatography (HPLC) analysis. Samples resulting in a positive detection from HPLC, were then subjected to gas chromatography/mass

spectrometer (GC-MS) analysis for final confirmation.

RESULTS

Confirmation analysis (GC-MS) for the 1996 season is in progress. Confirmed results for the entire 1995 season are shown in Tables 1 through 9. Although the growing season encompasses the time period from 5/31/95 to 8/18/95, this presentation of data seems more appropriate than showing results from the second half of 1995 and the first half of 1996. Preliminary results (not yet confirmed by GCMS) indicate similar trends during 1996. Overall, there were very few detectable pesticide residue concentrations in any of the water samples. Quinclorac (Table 1) was the only compound which exhibited a slightly persistent trend showing a gradual decrease in pesticide residue concentration. 2,4-D and molinate (Tables 2 and 6) show a typical pattern where the pesticides are detectable, sometimes at significant levels, shortly after application but were not detectable at the next sampling period.

Several compounds were detected at low levels in a very sporadic nature (carbofuran, carbaryl, propanil, methyl parathion, thiobencarb, and pendimethalin). Since some of these compounds were not applied to the actual fields being studied, the detections must result from a secondary source like irrigation water coming from a general water supply which receives runoff water from many different places.

Arkansas County - I: Since quinclorac was not applied at this site, the low level detections (Table 1) probably resulted from irrigation waters pumped from a nearby bayou. This bayou receives runoff water from neighboring rice fields which may have received quinclorac applications. These patterns for trace level detections were similar to those in earlier monitoring studies from 1994. 2,4-D was

only detected at one sampling period (Table 2). Propanil and molinate (Tables 5 and 6) were both applied at this site also. Table 6 shows that the molinate application was made sometime around 7/12/95 with rapid disappearance during the next two weeks. Sporadic detections of carbofuran and carbaryl (Tables 3 and 4) are probably the result of irrigation water coming from a general water supply.

Arkansas County - II: Quinclorac was applied at this site and its persisting residue pattern (Table 1) agrees with previous findings. Quinclorac tends to be one of the more persistent compounds in rice water and was detectable for about 4 - 6 weeks after flood establishment. This pattern is somewhat similar to the 1994 results where quinclorac persisted in water for up to 6 - 8 weeks. Sporadic, low level detections of propanil, molinate, and methyl parathion were also found.

Conway County: Similar to the Arkansas County - I site, the East site at this location utilized the availability of a nearby ditch for early season irrigation water. Since quinclorac was not applied at this site, the trace level detections on 5/31 (Table 1) probably resulted from this water source containing runoff from a neighboring quinclorac treated field. 2,4-D was detected at both the East and the West sites (Table 2). The observed pattern (especially from the East site) was very similar to results obtained from the Faulkner County location in 1994. This pattern indicates very rapid dissipation of the 2,4-D residues from the water (<2 weeks) with some sporadic trace levels occurring in the pond samples for several weeks. Several other compounds were detected in a sporadic manner with no observable trends.

Faulkner County: This site did have a quinclorac application made

and similar to the trend in Arkansas County - II, the residues were detectable for about 4 - 6 weeks after flood establishment (Table 1). 2,4-D detections were of a sporadic nature and at trace levels. Irrigation water for this particular site came from the Cadron Creek. Therefore, detectable levels of other compounds could be resulting from upstream sources.

Table 1. 1995 quinclorac detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	1	nd	nd	<1	nd	nd
Tailwater	NC	NC	nd	nd	1	nd	nd
Pond	NC	NC	<1	<1	nd	<1	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	26	7	5	nd	nd	nd
Pond	NC	NC	nd	<1	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	1	nd	nd	nd	nd	nd	NC
Drainage	<1	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	nd	nd	nd	nd	nd	nd	nd
Tailwater	2	8	4	nd	<1	nd	nd
Culvert	3	nd	nd	nd	nd	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = not available, Limit of quantitation = 1 ppb.

Table 2. 1995 2,4-D detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	nd	nd	nd	nd	nd
Tailwater	NC	NC	2	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	nd	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	205	nd	nd	nd	NC
Drainage	nd	nd	86	nd	nd	nd	NC
Pond	nd	nd	6	2	nd	3	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	44	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	nd	nd	nd	nd	nd	6	nd
Tailwater	nd	nd	nd	1	nd	nd	nd
Culvert	nd	nd	nd	nd	nd	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = 70 ppb, Limit of quantitation = 1 ppb.

Table 3. 1995 carbofuran detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	<1	nd	nd	nd	nd
Tailwater	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	nd	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	nd	nd	nd	nd	NC
Drainage	nd	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	6
FAULKNER COUNTY							
Irrigation	2	nd	nd	nd	nd	nd	nd
Tailwater	nd	nd	nd	nd	nd	nd	nd
Culvert	nd	nd	nd	nd	nd	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = 40 ppb, Limit of quantitation = 1 ppb.

Table 4. 1995 carbaryl detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	nd	nd	nd	<1	nd
Tailwater	NC	NC	nd	nd	nd	<1	<1
Pond	NC	NC	nd	nd	nd	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	nd	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	nd	nd	nd	nd	NC
Drainage	nd	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	<1
Drainage	NC	NC	nd	nd	nd	nd	<1
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	<1	<1	nd	nd	nd	nd	nd
Tailwater	nd	nd	nd	nd	nd	nd	nd
Culvert	nd	nd	nd	nd	nd	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = 700 ppb, Limit of quantitation = 1 ppb.

Table 5. 1995 propanil detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	nd	nd	nd	<1	nd
Tailwater	NC	NC	nd	nd	nd	<1	nd
Pond	NC	NC	nd	nd	nd	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	nd	nd	nd	nd	<1	nd
Pond	NC	NC	nd	nd	nd	<1	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	nd	nd	nd	<1	NC
Drainage	nd	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	<1
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	nd	nd	nd	nd	nd	<1	nd
Tailwater	1	<1	nd	nd	nd	<1	nd
Culvert	2	nd	nd	nd	nd	<1	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = not available, Limit of quantitation = 1 ppb.

Table 6. 1995 molinate detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	nd	nd	nd	nd	nd
Tailwater	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	26	<1	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	<1	nd	1	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	nd	nd	nd	nd	NC
Drainage	nd	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	nd	nd	nd	nd	nd	nd	nd
Tailwater	nd	nd	nd	nd	nd	nd	nd
Culvert	nd	nd	nd	1	nd	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = not available, Limit of quantitation = 1 ppb.

Table 7. 1995 methyl parathion detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	nd	nd	nd	nd	nd
Tailwater	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	1	NC	nd	NC	NC	nd
Runoff	NC	nd	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	nd	2	nd	nd	NC
Drainage	nd	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	7	nd	nd	nd	nd	nd	nd
Tailwater	nd	nd	nd	nd	nd	nd	nd
Culvert	nd	nd	nd	nd	nd	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = 2 ppb, Limit of quantitation = 1 ppb.

Table 8. 1995 thiobencarb detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	nd	nd	nd	nd	nd
Tailwater	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	nd	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	nd	nd	nd	nd	NC
Drainage	nd	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	nd	nd	nd	nd	nd	nd	nd
Tailwater	nd	nd	nd	nd	nd	nd	nd
Culvert	nd	nd	<1	nd	nd	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = not available, Limit of quantitation = 1 ppb.

Table 9. 1995 pendimethalin detections (ppb).¹

Water	Date of Collection						
	5/31	6/13	6/27	7/12	7/26	8/8	8/18
ARKANSAS COUNTY - I							
Irrigation	NC	nd	nd	nd	nd	nd	nd
Tailwater	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
ARKANSAS COUNTY - II							
Irrigation	NC	nd	NC	nd	NC	NC	nd
Runoff	NC	nd	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
CONWAY COUNTY - EAST SITE							
Irrigation	NC	NC	nd	NC	NC	NC	NC
Tailwater	nd	nd	nd	<1	nd	nd	NC
Drainage	nd	nd	nd	nd	nd	nd	NC
Pond	nd	nd	nd	nd	nd	nd	nd
CONWAY COUNTY - WEST SITE							
Irrigation	NC	NC	NC	NC	NC	NC	NC
Tailwater	NC	NC	nd	nd	nd	nd	nd
Drainage	NC	NC	nd	nd	nd	nd	nd
Pond	NC	NC	nd	nd	nd	nd	nd
FAULKNER COUNTY							
Irrigation	nd	nd	nd	nd	nd	nd	nd
Tailwater	nd	nd	nd	nd	nd	nd	nd
Culvert	nd	nd	nd	nd	1	nd	nd

¹NC = not collected, nd = not detected, Health Advisory Level (HAL) = not available, Limit of quantitation = 1 ppb.

CONCLUSIONS

Even though some pesticides were detected in the tailwaters, we see no evidence showing a pesticide buildup in the reservoirs. Overall, pesticide dissipation from water is very rapid; this is evident from observing residues at one sampling time and not detecting the pesticide two weeks later. As expected, the period of highest pesticide concentration in water occurs shortly following pesticide application. Therefore, containment of water on the field should be emphasized immediately following postemergence applications to flooded rice. Flushing early in the season, prior to permanent flood establishment, is most likely to cause loss of pesticides from preflood applications.

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