

Effect of Asulam in Wildlife Species Acute Toxicity to Birds and Fish*

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Asulam (methyl 4-aminobenzenesulfonyl carbamate) is a widely used herbicide active for control of dock (Rumex sp.), bracken fern (Pteridium aquilinum) and johnsongrass (Sorghum halepense). (HOLROYD et al, 1970; SOPER et al, 1968; TUCKETT and BALL, 1968).

The sodium salt of asulam has a high aqueous solubility and is used in the commercial formulation (Asulox^(R) herbicide) while the technical material is only slightly water soluble (0.5%) and virtually non-volatile.

The results of experiments conducted on sugarcane and European pasture grass indicate that asulam residues decline from 150-200 ppm initially to <0.1 ppm within 70 days in cane and are negligible in pasture grass within 14 days. Analysis of asulam in runoff water from sugarcane fields treated with 18 lbs ai/acre (label rate for sugarcane is 2-3 lbs ai/acre) shows 0.3 ppm residues at day of treatment and 0.03 ppm residues after two weeks (ANDREWS and MUGGLETON, 1972).

The work reported in this study is a summary of the acute toxicity experiments conducted to ascertain the hazard of asulam to wild-life species.

Materials and Methods

Four species of fish were used:

- 1) Rainbow trout (Salmo gairdnerii) averaging 3.4 grams.
- 2) Channel catfish (Ictalurus punctatus) averaging 2.98 grams.
- 3) Goldfish (Carassius auratus) averaging 2.72 grams.
- 4) Bluegill (Lepomis macrochirus) averaging 0.5 grams.

The fish were housed in 20 liter bioassay vessels in reconstituted deionized water containing:

- 1) 30 mg calcium sulphate (CaSO_4)/liter.
- 2) 30 mg magnesium sulphate (MgSO_4)/liter.
- 3) 48 mg sodium bicarbonate (NaHCO_3)/liter.
- 4) 3 mg potassium chloride (KCl)/liter.

The trout were tested at $16 \pm 1^\circ\text{C}$ and the remaining species at $24 \pm 1^\circ\text{C}$. The fish were tested in groups of ten with a maximum load of 2 fish per liter.

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The birds were housed in wire mesh cages and maintained on an ad libitum diet of chicken growers pellets and fresh water. The following avian species were tested:

- 1) Mallard duck (Anas platyrhynchos) 900-1200 grams.
- 2) Partridge (Perdix perdix) 320-500 grams.
- 3) Pheasants (Phasianus colchicus) 1100-0350 grams.
- 4) Domestic pigeons (Columba livia) 250-350 grams.

The five day subacute studies were conducted with pheasant chicks and mallard ducklings at 7 days of age. These birds were housed in controlled floor pens at 32°C and received the treated diet and water ad libitum.

Results

The asulam and DDT were dissolved in the bath solutions and expressed as parts per million (ppm) of active ingredient. A summary of the LC₅₀'s after exposure to asulam and DDT is given in Table 1.

TABLE 1 Summary of Asulam and DDT

96 hours LC₅₀ values in ppm¹

<u>Species</u>	<u>Asulam (ai)</u>	<u>DDT (ai)</u>	<u>95% Confidence Limits</u>
Rainbow trout	>5000	0.0038	(0.0034-0.0043)
Channel catfish	>5000	0.0135	(0.009-0.020)
Goldfish	>5000	0.0098	(0.0073-0.0132)
Bluegill	>3000	0.0022	(0.0018-0.0026)

1. Method of LITCHFIELD and WILCOXON (1949).

Twenty percent of the goldfish and channel catfish died at the 5000 ppm and 3000 ppm exposure levels respectively, while no other mortalities were observed at any other concentrations. Exposure to DDT resulted in a linear mortality response in each species tested.

The results presented in Tables 1 and 2 show that under the experimental conditions asulam was relatively non-toxic to the four species tested and these findings indicate that in normal use patterns asulam would not be hazardous to fish.

A summary of the results of the individual species response to asulam and DDT is given in Table 2.

The avian experiments were conducted in two phases. First, acute oral toxicity was determined in mallards, partridges, pheasants, and pigeons and second, five day feeding experiments were conducted with mallard ducklings and pheasant chicks. The results of the acute oral toxicity experiments are summarized in Table 3.

TABLE 2

Summary of Species Response
to Asulam and DDT

<u>Rainbow Trout</u>		<u>Channel Catfish</u>		<u>Goldfish</u>		<u>Bluegill Sunfish</u>	
<u>DDT</u>							
<u>Dose</u> ¹	<u>% Mort</u> ²	<u>Dose</u>	<u>% Mort</u>	<u>Dose</u>	<u>% Mort</u>	<u>Dose</u>	<u>% Mort</u>
0.0021	0	0.010	40	0.006	20	0.0018	20
0.0029	30	0.018	60	0.010	50	0.0025	60
0.0040	60	0.030	80	0.018	90	0.0035	90
0.0054	80	0.050	100	0.030	100	0.0050	100
0.0071	100	0.090	100	0.050	100	0.0070	100

Asulam

648	0	648	10	648	0	2000	0
1080	0	1080	0	1080	0	3160	0
1800	0	1800	0	3000	0		
3000	0	3000	20	5000	20	5000	0
5000	0	5000	20				

1. Dose is as ppm of active ingredient.
2. % mortality is total percent death after 96 hours.

TABLE 3

Acute Oral Toxicity of Asulam*

<u>Species</u>	<u>mg/kg Asulam</u>
Mallard	>4000
Partridge	>2600 but <4000
Pheasant	>4000
Pigeon	>4000

*LD₅₀

TABLE 4

Summary of Species Response to Asulam¹

<u>Dose</u>	<u>Mallard²</u> <u>(mg/kg) %</u> <u>mortality</u>	<u>Partridge²</u> <u>%</u> <u>mortality</u>	<u>Pheasant²</u> <u>%</u> <u>mortality</u>	<u>Pigeon²</u> <u>%</u> <u>mortality</u>
4000	10	70	20	0
2600	0	10	0	0
1600	0	10	0	0
Control	0	10	0	0

1. Percent mortality is total percent death after 21 days.
2. 5 males and 5 females were tested at each dose.

The 21 day mortality in each species is summarized in Table 4.

The birds that died were autopsied and no lesions were observed except serous fluid in the body cavity, edematous lungs, and congested liver. One male and one female partridge that died on day 2 after asulam administration had edematous crops containing straw colored mucoid fluid.

At the end of the observation period all birds were sacrificed and observed. No lesions were observed in any birds except three pigeons (one female from the 4000 mg/kg group; one female from the 2600 mg/kg group and one male control) in which fatty livers were seen.

The results of the eight day LC_{50} experiments in pheasant chicks and mallard ducklings indicated that asulam is relatively non-toxic and would not present a hazard to these species in the wild. No deaths were observed in asulam treated pheasant chicks at concentrations in the feed of up to 75,000 ppm and two ducklings died at 75,000 ppm while all survived at 100,000 ppm. The LC_{50} (DE BEER, 1945) of DDT in pheasant chicks was 750 ppm while in mallard ducklings the LC_{50} was 1550 ppm. Tremors and ataxia were observed in DDT treated ducks before death. No unusual

TABLE 5

Food Consumption and Body Weight Changes
in Pheasant Chicks Fed Asulam or DDT for 5 Days

Compound and dietary conc. (ppm)		Mean body weights (g)		Food consumption (g)	
		Initial Day 1	Gain Day 1-8	5 day Total	g/bird/day
Control	Control	42	33	510	10.2
	Control	40	39	700	14.0
	Control	41	41	800	16.0
	Control	40	42	660	13.2
	Control	40	44	820	16.4
	Control	40	38	680	13.6
Asulam	10,000	41	41	1340	26.8
	15,000	41	41	1320	26.4
	22,000	40	39	940	18.8
	33,000	41	39	740	14.8
	50,000	42	38	920	18.4
	75,000	40	36	470	9.4
DDT	320	41	44	880	17.6
	400	41	39	1300	26.0
	500	40	40	1180	23.6
	630	42	38	1180	25.6
	800	42	35	1220	24.4
	1,000	44	41	1160	23.2
	1,250	42	38	1000	20.8

signs were observed in birds in the control or asulam treated groups.

Food consumption was affected by both DDT and asulam in the diets. Summaries of food consumption data and body weight changes are given in Tables 5 and 6.

TABLE 6

Food Consumption and Body Weight Changes
in Mallard Ducklings Fed Asulam and DDT for 5 days

Compound and dietary conc. (ppm)		Mean body weights (g)		Food consumption (g)	
		Initial Day 1	Gain Day 1-8	5 day Total	q/bird/day
Control	Control	74	136	1410	28.2
	Control	74	138	1560	31.2
	Control	70	128	1410	28.2
Asulam	33,750	80	106	1300	26.0
	55,000	68	112	1080	21.6
	75,000	77	86	1020	20.8
	100,000	88	70	1200	24.0
DDT	330	77	119	1370	27.4
	500	72	104	1280	26.1
	750	73	115	1315	26.2
	1,100	74	86	1130	24.0
	1,650	84	63	940	19.6
	2,500	78	0	530	15.1

Discussion

Asulam is widely used for control of weeds in non-crop, pastureland and reforestation situations and therefore detailed experimentation has been conducted to determine the hazard to fish and wildlife. The results of the acute experiments reported here indicate a low order of toxicity resulting from massive doses of asulam being given by gavage, in the diet or bath waters. The decreased food intake at the higher doses of asulam may be suggestive of a loss of palatability due to the concentration of the compound and may account for the lesser weight gains in birds fed asulam at greater than 15,000 ppm or 1.5% of the total diet.

ALABASTER (1969) reported a very low order of toxicity to Harlequin fish (Rasbora heteromorpha) exposed to 520 ppm of asulam for 24 hours. The aquatic experiments reported here indicate that asulam is well tolerated in the species tested and is eight orders of

magnitude less toxic than DDT. These results support the findings of ALABASTER (1969). The solubility of asulam in water suggests that little or no accumulation would take place in fish or other fresh water species.

The general conclusion to be drawn from these data is that asulam is relatively non-toxic to fish and wildlife species and the residue levels in fields and drainage water are several orders of magnitude lower than the concentrations affecting the test animals. Therefore, it can be concluded that asulam presents a very low potential for hazard to wildlife in treated areas.

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