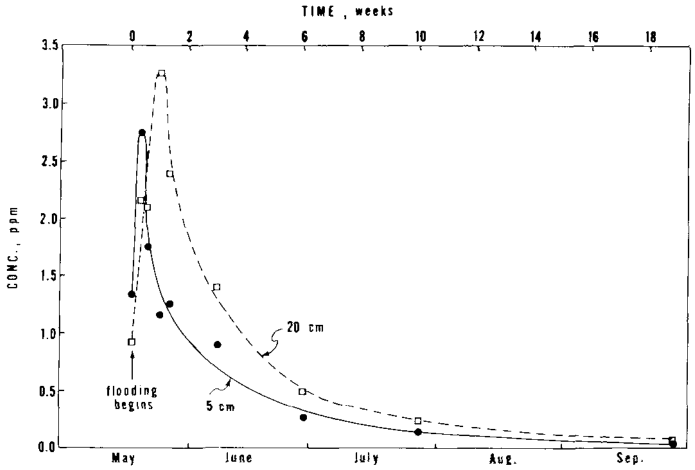
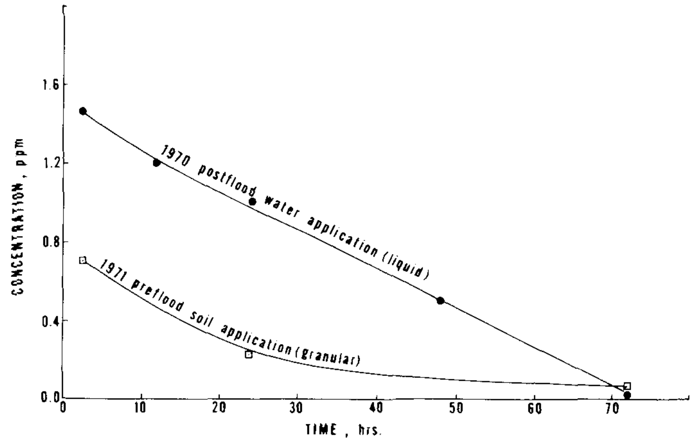
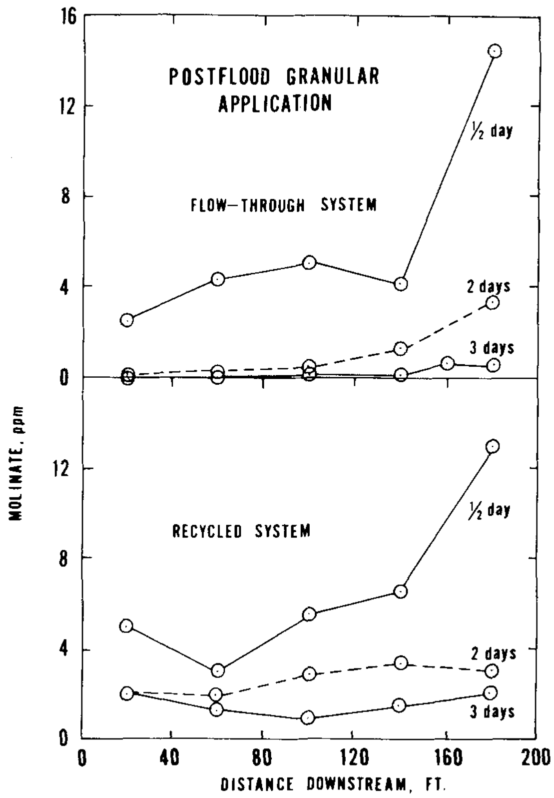
GRAPH NO. 1. 1971 CONCENTRATIONS OF SOIL-INCORPORATED MOLINATE IN SEEPAGE WATERS AT TWO SOIL DEPTHS THROUGHOUT THE GROWING SEASON IN STATIC AND RECYCLED WATER-MANAGEMENT SYSTEMS.



GRAPH NO. 3. 1970 AND 1971 CONCENTRATIONS OF MOLINATE IN THE SPILL-WATERS FROM A FLOW-THROUGH WATER-MANAGEMENT SYSTEM.



GRAPH NO. 2. 1972 DISTRIBUTION OF MOLINATE IN FLOODWATERS IN RECYCLED AND FLOW-THROUGH WATER-MANAGEMENT SYSTEMS



Herbicide Persistence And Movement Studies With Molinate in Rice Irrigation Management

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A THREE-YEAR STUDY was carried out in experimental plots at the U.C. Davis Rice Research Facility to determine the persistence and movement of molinate (Ordram) in flood and seepage waters. Application methods, formulations, rates and water management systems used in plot treatments are given in table 1. Molinate may be applied and incorporated into the soil surface before flooding and planting (preflood preplant application) or broadcast on the flood water after the watergrass has emerged (postemergence postflood application). Both liquid (Ordram 6E) and granular (Ordram 5G, Ordram 5GS, Ordram 10G) formulations are available. These experiments were conducted in strip plots (25 × 200 ft) under static, flow-through, and recycled systems of water management. (For details see article on dye tracer movement in rice strip plots, in the July 1973 issue of *California Agriculture*.) Magnitudes of water flows are also presented in table 1 for applied irrigation water (inflow), runoff (outflow), recirculation (recycled), water losses to the atmosphere (evapotranspiration), and losses due to percolation (seepage).

TABLE 1. APPLICATION METHODS, FORMULATIONS, AND RATES OF APPLICATION OF MOLINATE, AND WATER MANAGEMENT SYSTEMS AND WATER FLOWS

					Estimated water flow† for 25 × 200-ft strip plots				
Application method	Formulation	Application rate*	Water management systems	Flood water depth	Inflow	Outflow	Recycled	Evapotranspiration	Seepage‡
		lbs/ac		inches	gpm	gpm	gpm	inches/day	inches/day
Preflood preplant	Ordram 5GS (granular)	4	Flow-through	4	3.4	1.5	..	0.20	0.68
			Static	4	1.5	..	..	0.20	0.49
			Recycled	4	1.7	..	1.1	0.20	0.58
Post-emergence postflood	Ordram 5GS (granular)	3	Flow-through	3½	2.3	1.4	..	0.30	0.53
			Static	3	2.0	..	..	0.30	0.62
			Recycled	4	1.5	..	1.0	0.30	0.39
	Ordram 6E (liquid)	4	Static	6	1.5	..	..	0.20	0.49

* Active ingredients per acre.
† Flow during experimental period.
‡ Estimated by difference.

These studies investigated the persistence of molinate (a selective herbicide registered for use in rice culture to control watergrass, or barnyardgrass) in flood and seepage waters, residues, and extent and speed of chemical movement. Results from these and earlier experiments show that water management and circulation in flooded rice fields are important considerations. Regardless of how uniformly a chemical is applied, downstream movement of water tends to redistribute it. Gusty winds can also modify chemical distribution. The redistribution of chemicals can be minimized by holding flood waters for a few days after application. Soil incorporation gives less residue in flood waters and drains than does water application.

Preflood soil applications

Table 2 presents persistence data for preflood, preplant application of molinate for three water management systems. The herbicide was incorporated 3 inches deep into dry soil with a spring-tooth harrow. On May 18, 1971, the strip plots were flooded and seeded with rice. Persistence data are reported for three cross-sectional sampling stations for each water management system. As indicated in table 1 the spill of applied irrigation water was 44% for the flow-through system and none for the static and recycled systems. When molinate was incorporated into soil before flooding, its persistence was about three to five days. Regardless of the water management system, molinate was found in only trace amounts in flood-water samples taken up to May 27, 1971. The detection limit was 0.01 ppm with the analytical procedure used.

With respect to seepage waters, however, graph 1 shows that molinate persisted for at least four months. The two curves represent residue concentrations over time from suction-probe samples taken at 5 cm (2 inches) and 20 cm (8 inches) in the submerged soils. The curves connect data points which are averages of data from the static and recycled water management plots. Molinate (which is believed to be biodegradable) exhibits a long term persistence at low concentration levels in submerged soils, probably due to anaerobic conditions which prevent aerobic microbes from degrading the chemical. Furthermore, molinate may interact with soil and organic matter thereby rendering it unavailable for microbial degradation.

Postflood water applications

Graph 2 illustrates the difference in herbicide distribution along the length of the rectangular plots for postflood application of Ordram 5GS at 3 lbs active ingredients (ai) per acre in flow-through and recycled systems. This postemergence treatment involved broadcasting on the flood waters as uniformly as possible on June 27, 1972. Within half a day, however, the chemical had been redistributed in both systems by downstream flow of water. By the second and third days after application, molinate in flood waters in the top half of plots with the flow-through system had dropped in concentration, from the spilling of water at the lower end and from degradation. In flood waters of the recycled system, by contrast, the herbicide concentration remained more uniform, since flood waters containing higher concentrations of molinate at the lower end of the plot were recirculated to the inflow end and reapplied. It is assumed that the sinks (sorption, seepage, degradation, etc.) were similar in both systems, but the lack of spill and the recirculation in the recycled system mantained a better distribution of molinate and a more effective control of watergrass.

Table 3 contains molinate data in a static water management system in which Ordram 6E (liquid formulation) was applied as a postflood treatment on September 23, 1970. In contrast to the persistence data for the static system in table 2, molinate concentrations in the flood waters remained at relatively high concentrations for more than ten days. Both experiments were carried out in the absence of vegetation—in a bare unseeded plot in 1970, and a recently seeded plot in 1971. The only major difference appears to have been the water temperature: 52°F in 1970 and 63°F in 1971. It is conceivable that microbes which degrade molinate were not active at colder temperatures, and it is known that vapor losses to the atmosphere decline with temperature.

Table 4 gives 1970 molinate residues in submerged soils at 5 cm (2 inches), 15 cm (6 inches), and 25 cm (10 inches) depths. Molinate was first detected two days after application in seepage waters extracted from 5 cm and in trace amounts from 15 cm. By the tenth day after application molinate had percolated down to 25 cm.

Additional molinate data have been reported for postflood application of Ordram 6E in a flow-through system (July 1973 issue of *California Agriculture*). That report showed herbicide distribution as a function of both time after application and downstream distance. The persistence of molinate was shorter than the data reported here in table 3 because it was a flow-through system with the flood water spilled.

Graph 3 in this report compares molinate concentrations from a flow-through system in which the herbicide was applied in liquid form as postflood application, and in granular form as preflood soil incorporation. It shows that soil incorporation released less molinate residue in the spill waters than did water application.

Limitations of plot studies

These experiments on molinate persistence and movement reflect idealized and simple water-flow patterns, in contrast to commercial rice culture conditions. There, most fields are neither rectangular nor regular in shape, and the water tends to flow from upstream check boxes to downstream check boxes without circulating fully in the contour-leveed fields. The main water-flow pattern from check box to check box is more like the experimental flow-through system, whereas flow patterns in the centers of the flooded checks are more like the static or stagnant system. The recycled or recirculating system is more applicable to units larger than farm size, for example, on a district level.

Even though information from these rectangular strip-plot studies cannot be applied directly to conventional commercial fields (in space, time, or geometry), the results provide some basic knowledge on the behavior, persistence, and movement of molinate. These tests explored alternative water management systems, field geometry, and herbicide application techniques which may provide some guidelines toward minimizing the spill of chemical residues into return-flow systems from rice fields. But these experimental results and techniques must be weighed against other rice-culture operations and practices—for example, fertilizer practice, insecticide control, water flow, and water deliveries.

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TABLE 2. MOLINATE PERSISTENCE IN FLOOD WATERS, 1971, PREFLOOD PREPLANT APPLICATION, ORDRAM 5GS AT 80 lb/acre

Water management system	Down-stream station*	Molinate concentration			
		May 18	May 20	May 21	May 25
	ft	ppm	ppm	ppm	ppm
Flow-through	20	0.08	0.06	0.06	< 0.01
	100	0.16	0.10	0.11	< 0.01
	180	0.78	0.23	0.06	< 0.01
Static	20	< 0.01	< 0.01	< 0.01	< 0.01
	100	0.35	0.29	0.10	< 0.01
	180	0.90	0.60	0.08	< 0.01
Recycled	20	0.48	0.25	0.15	< 0.01
	100	...†	0.28	0.18	< 0.01
	180	1.02	0.69	0.19	< 0.01

* Downstream from water-inflow end.
†Sample lost.

TABLE 3. MOLINATE PERSISTENCE IN FLOOD WATERS, 1970, POSTFLOOD APPLICATION OF ORDRAM 6E AT ½ gal/ac IN A STATIC SYSTEM

Date	Molinate concentrations (ppm) at downstream sampling stations				
	20 ft	60 ft	100 ft	140 ft	180 ft
September 23*	1.82	0.95	1.15	1.13	1.14
September 25	0.79	1.00	0.57	0.75	0.71
September 28	0.45	0.46	0.61	0.78	0.65
October 3	0.44	0.34	0.34	0.37	0.24

* 2 hrs after spraying.

TABLE 4. MOLINATE CONTENTS IN SEEPAGE WATERS, 1970, POSTFLOOD APPLICATION OF ORDRAM 6E AT ½ gal/ac IN A STATIC SYSTEM

Date	Molinate concentrations* (ppm) in seepage waters of submerged soils		
	5-cm depth	15-cm depth	25-cm depth
September 23†	<0.01	<0.01	<0.01
September 25	0.35	0.07	<0.01
September 28	0.38	0.26	<0.01
October 3	0.43	0.32	0.04

* Average from stations 20, 60, 100, 140, and 180 ft downstream.
† 4 hours after application.

Wetting agents for eros[ion control] on burned water[sheds]

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Photo 1. Checkerboard pattern (center) representing surfactant treated areas in the study. The fan-shaped wetted areas to the left and right indicate areas irrigated by the Forest and Range Experiment Station.

THE MANY ACRES of watershed in Southern California that burn each year constitute a serious potential for erosion, because the removal of protective vegetation and fire causes the land to become water repellent—instead of being absorbed, water tends to run off.

To decrease erosion, the burned watersheds are commonly seeded with annual ryegrass (*Lolium* spp.), but seed germination depends on characteristics of the first seasonal rainfalls, which also determine severity of erosion prior to vegetative establishment.

To overcome these problems, wetting agents have been used to treat water repellent soils. Addition of a wetting agent to water allows the water to penetrate the soil rather than run off. Furthermore, a water-repellent soil which has been treated with wetting agent solution is wettable after redrying, since the wetting agent molecules are absorbed by soil particles. If only a small amount of wetting agent is applied, it all can be adsorbed near the soil surface, leaving lower layers of soil unaffected.

Demonstration plots

Demonstration plots for testing the use of a wetting agent were established in the winter of 1970–71 near the mouth of the San Antonio Canyon in the San Gabriel Mountains north of Upland, California. The area had been burned during the summer. The plots were watered with approximately one-half inch of 5000 ppm wetting agent solution. Water was pumped through a fire hose and sprayed on demonstration plots using a chemical injection pump to mix the wetting agent with water as it was applied.

Three sites were selected for treatment. One was the checkerboard area in photo 1, taken immediately following treatment. The fan-shaped dark areas which contain subplots of wetting agent treat-