

Effects of Long-Term Preemergence Herbicide Use on Growth and Yield of Citrus¹

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Abstract

The effects of several preemergence herbicides at various rates were tested on bearing 'Redblush' grapefruit trees and non-bearing Navel orange trees. Some of the preemergence herbicides caused foliar injury symptoms on the trees including Hyvar X, Diuron, and Krovar I although they did not cause significant yield reductions in the short time period of this experiment. Several herbicides including Solicam, Surflan, and Prowl did not cause foliar injury or reduce yield and provided good weed control for various lengths of time. The Prowl treatments provided the longest period of weed control in the experiment on bearing grapefruit trees.

Introduction

The use of preemergence herbicides for controlling weeds in citrus groves appears to be losing favor with some growers and many weed control programs are currently relying on postemergence herbicides or discing. Disking orchards occasionally damages tree branches and, in the opinion of some growers, may damage shallow tree roots. Citrus growers in central Arizona have extensively used the preemergence herbicide Krovar I (a premix of diuron and bromacil) for the control of weeds in citrus groves. Recently, growers have noted a decline in yields in orchards where Krovar I has been used for many years. A few have stopped using Krovar I in portions of orchards and feel that they have seen an increase in yields. Preemergence herbicides have not been widely used in Yuma County in the past because flood irrigation of sandy soils, especially on the Yuma Mesa, can leach some herbicides such as bromacil (e.g., Hyvar X and Krovar I), diuron (e.g., Karmex, Krovar I), and simazine (e.g., Princep) into the tree root zone resulting in foliar injury. The perception is that long-term use of preemergence herbicides damages citrus trees. However, there are many preemergence herbicides that do not cause tree injury and provide good weed control including Goal, Prowl, Solicam, Surflan, and Treflan. The objective of this study was to demonstrate and evaluate the long-term effects of preemergence herbicides on citrus trees.

¹The authors wish to thank the Arizona Citrus Research Council and the Yuma County Pest Abatement District for partial financial support of this project. This is a final report for project 95-03 'Effects of Long-Term Preemergence Herbicide Use on Growth and Yield of Citrus'.

Materials and Methods

This study included two experiments, one on bearing citrus and one on non-bearing citrus. The experiment on bearing citrus was initiated in the March of 1995 in a flood irrigated, 5 year old grove containing 'Redblush' grapefruit on a sour orange rootstock at the Gila River Indian Farms in Pinal County. Weed control in the grove prior to the beginning of the experiment was accomplished by disking. The treatments consisted of an untreated control and individual or tank mixed applications of preemergence herbicides (see Table 1) arranged in a randomized complete block experimental design. Each plot consisted of a single tree. The preemergence herbicides were applied on 3/2/95, 12/7/95, and 12/10/96 and irrigated the day after application to incorporate the herbicides. A CO₂ pressurized backpack sprayer and a specially constructed boom that sprayed a 100 inch wide pattern was used to apply the treatments. The boom contained 4 TeeJet XR8003VS nozzles on 18 inch centers and one TeeJet OC-03 nozzle 11 inches from the other nozzles. The spray pressure was about 30 psi and the applicator paced around the perimeter of the trees at 3 mph. Trees were rated for foliar injury in the spring of 1995 and 1996 (Table 1). Tree injury in the form of foliar symptoms was rated from 0 (no injury) to 5 (most leaves exhibiting injury). Weed control was visually evaluated in the spring of each year to determine effectiveness of each treatment (Table 1). Weed control was rated from 0 (no weed control) to 10 (complete weed control). Trees were individually harvested to measure yield on 2/20/96 and 5/7/97. A smaller experiment was conducted in Waddell with the Bodine Company to evaluate preemergence herbicides on non-bearing Navel orange trees. The treatments were arranged in a randomized complete block design in which individual trees were the plots. This grove was irrigated with micro-sprinklers so we attempted to apply the herbicides prior to significant rainfall. The preemergence herbicides (see Table 3) were applied as described above on 1/25/96 and 1/17/97. Significant rainfall occurred following the 1/25/96 applications but not after the 1/17/97 applications.

Results and Discussion

In the experiment at the Gila River Indian Farms on bearing trees, foliar injury was detected on trees which were treated with Hyvar, Diuron and Krovar in both years. In addition, as the rate of each herbicide increased the level of tree injury likewise increased. Several preemergence herbicides did not cause leaf or tree injury including Princep, Solicam, Prowl and Surflan (Table 1). Weed control was visually evaluated in the spring of each year to determine the effectiveness of each treatment (Table 1). Plots receiving Solicam or Prowl alone, or a tank mix of Solicam and Prowl provided good weed control (Table 1). Surflan provided good weed control in 1995, but marginal control in 1996. The difference between the two years for the Surflan treatments was related to the time between treatment and evaluation, 3 and 5 months, respectively, in 1995 and 1996. Hyvar, Diuron, Princep and Krovar provided minimal weed control in both years. Weed control in the Prowl treated plots had the greatest longevity with good weed control 9 months after treatment (data not shown), where as the other treatments were no longer providing weed control after 9 months. Although, Prowl performed well, providing excellent long-term weed control with no tree injury, Prowl is currently registered only for non-bearing citrus trees. We hope that a registration for bearing trees will be available soon. The grapefruit grove was harvested in February 1996 and May 1997. There were no significant differences in fruit yield between treatments in 1996. There was a large variation in yield between trees in 1996 that was probably due to freezing temperatures and high winds during bloom that reduced our ability to detect treatment differences. The yield data collected in 1997 was somewhat more uniform but also did not indicate that there were yield differences between treatments. Thus, the injury observed in some of the treatments, particularly Hyvar, was not severe enough to cause yield reductions.

In the experiment in a non-bearing navel orange grove, some rainfall occurred following the preemergence herbicide applications in 1996 that incorporated the herbicides to an uncertain extent. Thus, data on tree injury and weed control were collected in 1996. The herbicide rates in this experiment were quite high in order to adequately test the safety of the herbicides on small non-bearing trees. None of the herbicides caused tree injury (Table 2) and most treatments provided good weed control (Table 2). No rainfall occurred following the herbicide applications in 1997, thus, we were unable to evaluate either tree injury or weed control. A major problem in this experiment has been the uncertain degree of incorporation or lack of incorporation of the herbicides in a timely manner following application. This has resulted in unknown concentrations of the herbicides in the weed and tree root zone. Thus, we can make no reliable conclusions about herbicide efficacy or safety and so we have terminated the experiment in the Navel orange grove.

Table 1. Effect of preemergence herbicides on tree injury, weed control and yield in a 'Redblush' grapefruit grove.

Treatment	lb a.i. per acre	Tree injury & weed ratings 5-18-95				Tree injury & weed ratings 5-22-96				Harvest 2-20-96		Harvest 5-7-97	
		Tree Injury	Tumble pigweed	Jungle rice	Tree injury	Tumble pigweed	Jungle rice	Fruit weight	Fruit number	Fruit weight	Fruit number		
Control		0.0 d	0.0 d	2.5 b	0.0 e	0.0 e	0.0 c	50	46	174	151		
Hyvar X80WP	2.4	1.7 bcd	9.3 ab	7.0 a	1.9 bc	3.5 de	3.3 b	50	50	133	119		
Hyvar X80WP	3.2	3.2 ab	8.3 ab	9.5 a	2.6 b	5.1 bcd	4.3 b	47	46	119	110		
Hyvar X80WP	4.8	4.1 ab	9.0 ab	10.0 a	3.8 a	4.8 cd	3.0 bc	62	60	132	115		
Diuron 80WP	1.6	0.0 d	9.0 ab	9.0 a	0.0 e	2.0 de	1.5 bc	76	72	147	126		
Diuron 80WP	2.4	0.4 cd	7.8 b	9.0 a	0.0 e	1.8 de	2.3 bc	67	68	131	113		
Krovar I	4.0	0.6 cd	9.6 a	9.9 a	0.4 de	2.4 de	3.3 b	40	39	137	124		
Krovar I	5.0	2.1 bc	10.0 a	10.0 a	1.1 cd	2.5 de	2.5 bc	51	49	128	115		
Princep 80WP	1.6	0.0 d	9.3 ab	9.3 a	0.0 e	4.6 cd	2.8 bc	54	52	149	129		
Diuron 80WP+ Princep 4 FL	1.6	0.6 cd	9.8 a	9.8 a	0.3 de	5.9 a-d	2.1 bc	52	50	131	111		
Solicam 80DF	3.0	0.0 d	9.5 ab	10.0 a	0.0 e	8.0 abc	8.5 a	57	56	140	124		
Solicam 80DF	5.0	0.0 d	9.9 a	10.0 a	0.0 e	9.6 a	9.7 a	81	81	167	149		
Solicam 80DF+ Surflan 4FL	3.0 4.0	0.0 d	10.0 a	10.0 a	0.0 e	9.0 ab	9.5 a	74	72	154	137		
Surflan 4FL	4.0	0.0 d	9.9 a	10.0 a	0.0 e	3.4 de	4.6 b	73	72	146	129		
Surflan 4FL	6.0	0.0 d	10.0 a	10.0 a	0.0 e	3.8 de	4.0 b	72	69	139	125		
Prowl 3.3EC	4.0	0.0 d	9.8 a	9.9 a	0.0 e	9.9 a	9.9 a	69	66	158	141		
Prowl 3.3EC+ Solicam 80DF	4.0 3.0				0.0 e	9.9 a	10.0 a	80	76	152	120		

Treatment means followed by the same letter are not significantly different P=0.05 according to Tukey's HSD.

Table 2. Preemergence herbicide ratings of tree injury and weed control in a non-bearing navel orange grove.

Treatment	ai/A	Tree injury and weed ratings 5-16-96					
		Tree injury	Purple nutsedge	Pigweed complex	Spotted spurge	Lambs quarter	Golden crown beard
Control		0	0	0	0	0	0
Goal	2	0	0	93.8	60	100	97
Goal	3	0	10	60	63.3	97.5	70
Prowl	4.8	0	0	96.3	76.3	97.5	67.5
Prowl	7.2	0	0.5	97.5	92.8	98.8	91.3
Solicam	5	0	81.3	88.3	41.3	97.5	100
Solicam	7.5	0	86.8	92.5	62.5	100	100
Surflan	6	0	0	88.8	53.8	96.3	97.5
Surflan	9	0	0	100	66.3	98.8	95
Prowl + Solicam	4.8 5	0	87.5	100	87.5	100	100