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Preplant Use of 2,4-D in Rice

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Introduction

Interest in reduced tillage or no-till crop production has increased during the past few years. No-till systems involve seeding a crop into the residue of another crop with minimal soil disturbance. Stale seedbed systems involve fall- or early-spring seedbed preparation, but no soil disturbance immediately before planting. Both no-till and stale seedbed production systems require herbicide applications to control vegetation before planting (*4, 5*). Reduced tillage helps decrease soil erosion and compaction while saving time and reducing production costs (*4, 5*). However, herbicides applied before planting have caused crop injury and decreased yields in crops such as cotton, corn, soybeans, and rice (*14, 15*). Crop sensitivity, soil chemical composition, and environmental conditions influence herbicide persistence (*14*). Various detoxification methods,such as localized applications of carbon, have been used to detoxify the herbicide 2,4-D, but this may not provide protection during germination (*7, 11*).

As with conventional crop production systems, successful crop production in reduced tillage systems is best when vegetation is controlled at planting and the crop is maintained weed free for the remainder of the growing season (*25*). Slife (*19*) reported that 1-2 pounds of active ingredient per acre (ai/A) of 2,4-D provided effective

weed control when applied 3-7 days after planting corn when coupled with 3 cultivations during the growing season. Control of broadleaf weeds has been achieved with 2,4-D, but its use in no-till corn and soybeans has been reported to cause injury and significantly reduce corn yields (*19, 24, 26*). Reports indicate that combining 2,4-D with other herbicides improved weed control and did not decrease yields (*9, 10, 26*). There is a lack of information concerning 2,4-D in no-till and stale seedbed rice production with currently grown cultivars.

Preemergence applications of pendimethalin have been shown to injure emerging rice (*12*). Sensitivity to pendimethalin could be related to mesocotyl length, which varies among cultivars and could make some varieties more susceptible to injury. Sullivan (*22*) reports some varieties are more tolerant to preemergence applications of pendimethalin because they have shorter mesocotyls. One reason for this is subsequent development of the coleoptile node one half-inch or more below the treated soil surface. Susceptible varieties possess elongated mesocotyls, which allows the coleoptile node to develop at the soil surface and sustain more injury from the herbicide. Semi-dwarf rice cultivars often have a short mesocotyl which may allow them to escape injury (*22*).

Residue of 2,4-D should not persist for long periods because its half life is 4 days (*1, 2, 6, 23*). Furthermore, the breakdown of 2,4-D is not delayed by the application of other pesticides (*20*). Degradation is proportional to the 2,4-D concentration and soil type (*1*). Aerobic degradation of 2,4-D occurs rapidly in silty clay and sandy loam soils at depths ranging from 6-35 inches (*17*), but dissipation studies indicate that more than 95 percent of applied 2,4-D moves less than 6 inches (*3*). Crop sensitivity to 2,4-D varies with the age of the plant and amount of herbicide used. Germinating rice seeds are sensitive to 2,4-D (*18*). In Mississippi, 2,4-D cannot be applied within 28 days of planting rice[1]. Jordan et al. (*15*) noted rice injury ranged from 42-88 percent when 2,4-D was applied the day of planting. Decreased rice yields were reported when 2,4-D was applied the day of planting; in one-fourth of the trials, decreased yields were reported when 2,4-D was applied 7 or 14 days before planting. Rice is tolerant of 2,4-D and MCPA at the early-jointing growth stage or when internodes are between 0.2 to 0.5 inch long (*21*).

Cutleaf evening primrose (*Oenothera laciniate* Hill), Pennsylvania smartweed (*Polygonum pensylvanicum* L.), and curly dock (*Rumex crispus* L.) are controlled by 2,4-D, paraquat, thifensulfuron, tribenuron, or combinations of these herbicides (*7, 8*). However, applications of thifensulfuron plus tribenuron cannot occur within 45 days of planting rice[2]. Herbicides such as glyphosate and paraquat can be used before rice emergence (*13, 16*). Bollich et al. (*4,5*) compared no-till and stale seedbed production with conventional production. Glyphosate applied to stale seedbeds resulted in yields comparable to conventional seedbed production in both water-seeded and drill-seeded rice. All no-till treatments had significantly lower yields (*4*). In certain situations, preplant weed control is difficult to achieve with present restrictions on the use of 2,4-D and thifensulfuron plus tribenuron. Finding more flexible preplant intervals for these herbicides will give more options in preplant weed control (*15*). The objective of these experiments was to evaluate rice response to preplant applications of 2,4-D.

Materials And Methods

Experiments were conducted from 1993 to 1995 at the Delta Research and Extension Center in Stoneville, Mississippi. Test design was a randomized complete block replicated four times. Soil type was Sharkey clay (Vertic Haplaquept) with a pH of 7.4 and 1.2 percent organic matter content. Plots were 8-by-15 feet. Conventional (tilled prior and after herbicide application) and stale seedbeds were treated with 1 pound ai/A of 2,4-D amine at 0, 1, 2, 3, 4, or 5 weeks before planting (WBP) rice. 'Lemont' rice was drill seeded 0.75 inch deep in 8-inch rows at a seeding rate of 90 pounds per acre. Standard rice production practices were used to maximize yield. Rice injury was evaluated 7 days after emergence, and rice yields were determined at maturity. Data for each year were subjected to analysis of variance procedures and means were separated using the Waller-Duncan multiple range test (P=0.05). There was a significant year-by-treatment interaction; thus, data are presented by year.

Results and Discussion

In addition to rice stand reduction, rice injury consisted of twisted, rolled leaves, and curving of emerging plants. Rice injury for all 3 years was highest when 2,4-D was applied in either production system within 7 days of planting (Table 1). When 2,4-D was applied 0 WBP in 1993, 1994, and 1995, rice injury in conventional seedbeds was 39, 20, and 63 percent, respectively (Table 1); rice injury in stale seedbeds was 45, 26, and 43 percent, respectively. Rice injury was greater in the 0 and 1 WBP treatments in 1995 than in previous years. Rainfall in 1995 occurred within 48 hours of 2,4-D application, which could have moved the herbicide into the zone of seed germination. Soil moisture was high after planting, and germination occurred rapidly. Germinating rice is sensitive to 2,4-D, and injury increases with soil moisture (7, 26). Rice injury from application of 2,4-D in conventional seedbeds at 1 WBP was 9 percent during both 1993 and 1994 (Table 1). In stale seedbeds treated 1 WBP, rice injury was 15 percent during both these years. When 2,4-D was applied 1 WBP in 1995, injury was 90 percent in conventional seedbeds and 78 percent in stale seedbeds. Rice was not significantly injured when 2,4-D was applied 2 or more weeks before planting (Table 1).

Although rice injury did occur in 1993, 2,4-D did not reduce rice yields regardless of application timing in either production system (Table 2). In 1994, when soil was tilled before planting, 2,4-D did not reduce rice yields at any application timing. However, rice yields were reduced in the stale seedbed system when 2,4-D was applied the day of planting, but the recorded injury was low. In 1995, rice yields were reduced in the conventional seedbeds when treated 0 or 1 WBP and in stale seedbed when treated 1 WBP. In 1995, application of 2,4-D to stale seedbeds at 0 WBP did not reduce yields, although injury occurred (Table 2).

In summary, application of 2,4-D amine 2 or more weeks before planting did not significantly injure rice or cause yield reductions in either conventional or stale seedbed dry seeded rice production systems. Yields were reduced in only 1 of 3 years when 2,4-D was applied 1 week before planting, and this was coincidental with rainfall occurring within 48 hours of 2,4-D application. These data indicate that 2,4-D could be used without significant rice injury if applied 2 or more weeks before planting.

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[1]Weedar 64 herbicide label. Rhone-Poulenc Agricultural Company, 2 T.W. Alexander Drive, Research Triangle Park, NC 27709.

[2]Harmony Extra herbicide label. DuPont Agricultural Products, Walker's Mill, Barley Mill Plaza, Wilmington, DE 19898.

Table 1. Rice injury 7 days after emergence with various application timings of 2,4-D in conventional and stale seedbeds.

Timing	Rate	Rice injury[1]		
		1993	1994	1995
	lb ai/A	*%*	*%*	*%*
Conventional				
Untreated	0	0 d	0 d	0 d
0 WBP[2]	1	39 a	20 b	63 b
1 WBP	1	9 bc	9 c	90 a
2 WBP	1	4 bc	0 d	0 d
3 WBP	1	6 bc	0 d	0 d
4 WBP	1	3 c	0 d	0 d
5 WBP	1	1 c	0 d	0 d
Stale Seedbed				
Untreated	0	0 c	0 d	0 d
0 WBP[2]	1	45 a	26 a	43 c
1 WBP	1	15 b	15 b	78 a
2 WBP	1	5 bc	0 d	5 d
3 WBP	1	8 bc	0 d	0 d
4 WBP	1	1 c	0 d	0 d
5 WBP	1	1 c	0 d	0 d

[1]Means within a column followed by the same letter are not significantly different according to Waller-Duncan's Multiple Range test (P=0.05).

[2]WBP = Weeks Before Planting.

Table 2. Rice yield with various 2,4-D application timings in conventional and stale seedbeds.

Timing	Rate	Rice yield[1]		
		1993	1994	1995
	lb ai/A	*lb/A*	*lb/A*	*lb/A*
Conventional				
Untreated	0	6,566 c	7,745 ab	6,869 ab
0 WBP[2]	1	6,992 abc	6,888 bcd	5,920 cd
1 WBP	1	6,930 abc	8,144 a	3,794 e
2 WBP	1	6,719 bc	7,715 abc	6,088 bcd
3 WBP	1	7,033 abc	7,221 a-d	6,510 abc

4 WBP	1	7,023 abc	6,972 bcd	6,406 abc
5 WBP	1	6,939 abc	7,487 abc	6,172 bcd
Stale Seedbed				
Untreated	0	7,337 ab	6,721 bcd	7,289 a
0 WBP[2]	1	7,184 ab	5,529 e	6,810 abc
1 WBP	1	7,245 ab	6,794 bcd	5,364 d
2 WBP	1	7,186 ab	7,121 a-d	7,195 a
3 WBP	1	7,215 ab	6,609 cd	7,252 a
4 WBP	1	7,095 abc	6,321 de	7,334 a
5 WBP	1	7,377 a	6,945 bcd	6,766 abc

[1]Means within a column followed by the same letter are not significantly different according to Waller-Duncan's Multiple Range test (P=0.05).

[2]WBP = Weeks Before Planting.