Factors Influencing the Activity of Soil Incorporated Herbicides

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The Herbicides Used in this Research Work were Supplied by the Following Companies

Bensulide — **Stauffer Chemical Company**

C-6313, C-6989, Fluometuron—**Ciba Agrochemical Co.**

CP-50144, Propachlor—**The Monsanto Company**

D-497—**Amchem Products Inc.**

Nitralin—**Shell Chemical Company**

Prometryne, Propazine—**Geigy Agricultural Chemical Company**

Trifluralin—**Glanco Products Company**

UC-22463—**Union Carbide Corporation**

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Herbicides may be used to control weeds at many different times in the life cycle of a crop plant. In recent years two times of application have become particularly important in cultivated crops in Oklahoma. The first of these is "preplant"—the application of a herbicide prior to the planting of a given crop for weed control in that crop. The second is "preemergence"—application of the herbicide after planting but before the emergence of the crop. There is usually a period of about one week after planting for preemergence applications to be made. However, most often preemergence applications are made at the time of planting by mounting the spray nozzles on the planter.

Both preplant and preemergence herbicides are applied to the soil surface. After application they may be either left in place on the soil surface or they may be mixed into the soil. The process of mixing a herbicide into the soil has come to be known as "soil incorporation" or just "incorporation", and a herbicide used in this way is often called an "incorporated" herbicide. Both preplant and preemergence herbicides may be incorporated, but in Oklahoma usually only preplant herbicides are incorporated. Preemergence incorporation is more difficult to do effectively, and requires special equipment.

There are many different ways a herbicide may be incorporated into the soil. Preliminary experience has shown that the degree and efficiency of incorporation may drastically affect the activity of a herbicide (1). Thus, the several experiments described in this bulletin were designed to determine how to best use incorporated herbicides in the low organic matter soils and under the low rainfall conditions characteristic of Oklahoma. The experiments were conducted at Stillwater, Chickasha, Ft. Cobb and Altus, where average annual rainfall conditions varied from 18 to 34 inches per year.

Materials and Methods

Many different herbicides were used in this series of experiments. They are designated by their "common" names or numbers. These differ from the "trade" or "product" names seen on the dealers shelf. Table 1 lists all the herbicides used—by common name, chemical name and trade name.

All of the herbicides used in these studies were applied to the soil with an experimental-plot tractor-mounted sprayer designed by the senior author. In this way accurate application could be made consistently. All herbicides were applied in 30 gallons of water carrier per acre. With the exception of the method of application studies, all plots were incorporated with either a tandem disk (cross disked) or with a power rotary tiller. In 1965 and 1966 the rotary tiller was a garden type roto-spader, in 1967 it was a tractor mounted tiller. Plots were replicated at least four times in all experiments. All herbicides were applied as broadcast treatments over the entire plots.

Various crops were grown in these experiments. However, in all instances the herbicides used were known to be safe for the particular crop involved in that experiment—whether it be cotton, peanuts or sorghum. Since the objective of these experiments was to determine the efficiency of weed control, crop injury or yield data is not given unless it is directly involved with the activity of the herbicide.

Table 1—Common, Chemical and Product Names of the Herbicides Used.

Common Name	Chemical Name	Registered Trade Name
Bensulide	*N*-(2-mercaptoethyl) benzenesulfonamide *S-(0, 0*-diisopropyl phosphorodithioate)	Prefar
C-6313	N-(4-bromo-3-chlorophenyl)-N'-methoxy-N'-methyl urea	Maloran
C-6989	2,4-dinitro-4-trifluoromethyl-diphenylether	None
CP-50144	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide	Lasso
D-497	1,1,4-trimethyl-6-isopropyl-5-indanyl ethyl ketone and 7-indanyl isomer	Sindone B
Fluometuron	3-(m-trifluoromethylphenyl)-1,1-dimethylurea	Cotoran
Nitralin	4-(methylsulfonyl)-2,6-dinitro-*N, N*-dipropylaniline	Planavin
Prometryne	2, 4-bis(isopropylamino)-6-methylmercapto-*s*-triazine	Caparol
Propachlor	2-chloro-*N*-isopropylacetanilide	Ramrod
Propazine	2-chloro-4,6-bis(isopropylamino)-*s*-triazine	Milogard
Trifluralin	*a,a,a*-trifluoro-2,6-dinitro-*N,N*-dipropyl-*p*-toluidine	Treflan
UC-22463	80% 3,4-dichlorobenzyl-N-methylcarbamate	None

After the plots were established they were periodically visited and evaluated. Visual estimations were made of the weed control obtained as a result of the treatment applied to each plot. These estimations were made for both annual grass weeds ("grass" in the tables) and annual broadleaf weeds ("brlv" or "broadlf" in the tables). The dominant grass weed was crabgrass (*Digitaria sanguinalis*), although coloradograss (*Panicum texanum*), junglerice (*Echinochloa colonum*) and red sprangletop (*Leptichloa filiformis*) were present on occasion. Several different pigweeds (careless weeds) were present although green (*Amaranthus hybridus*), tumble (*A. albus*) and spiny (*A. spinosus*) predominated.

In addition to the visual estimates of weed control the plots were sometimes cleaned up by hoeing. While doing this the number of seconds necessary to clean up each plot was recorded. These times were later converted to the hours per acre that would be needed to clean up a field with that level of weed infestation. This data is reported in the tables as "Hoe Times (Hr/A)". Sometimes weed yields were obtained by harvesting the weeds in each plot and converting this to pounds or tons of weeds per acre.

Where the procedures used in particular experiments varied from the above methods there will be a discussion in the section involved.

Time of Incorporation

Experiments were established at various locations in order to determine at what time interval prior to planting herbicides could be incorporated into the soil. Owen reported that trifluralin could be incorporated from March onward (4). Time of incorporation experiments on weed control in cotton were conducted at Chickasha, those in grain sorghum at Stillwater, and in soybeans at Perkins. In all instances the herbicides were applied the indicated number of days prior to planting and then immediately incorporated by cross disking.

The cotton experiment at Chickasha was conducted on a silt loam soil. Both years the cotton was planted in mid May. The first herbicide application was approximately 81 days before planting in mid February. The second application (on other plots) was made about 50 days prior to planting, in mid March. The third application date was about 21 days prior to planting, in the latter part of April. The plots were six rows wide and 50 feet long, replicated four times. Nothing was done to the plots between the time of herbicide application and planting cotton except such practices as were needed to keep the soil in good condition for planting.

Four herbicides at two rates each were used in this experiment. Table 2 shows the percent control of grass and broadleaved weeds. Grass control with both trifluralin and nitralin was essentially perfect regardless of the interval between treatment and planting. Broadleaf weed control was not quite as good but was very acceptable with both materials regardless of the interval. Fluometuron at the lower rate did not do quite as well at the 81 day interval as at subsequent intervals, nor as well as the high rate did at all intervals. The high rate provided good weed control at all intervals. Prometryne caused some weed control at the 81 day interval but was more satisfactory when used at the 50 and 21 day intervals.

Hoe time and yield data are shown for these experiments in Table 3. This data somewhat confirms the control figures shown in Table 2. Hoe times in general were very good, showing considerable reduction below the check in all instances. Again trifluralin and nitralin performed satisfactorily regardless of the interval. The low rate of fluometuron applied 81 days prior to planting was not as effective as the high rate at that date or as fluometuron applied at closer to planting. Prometryne did not do quite as well at the two pound rate as at the three pound rate, and apparently should not be applied 81 days prior to planting. Prometryne apparently could be incorporated in these experiments within 21 days of planting and still provide good weed control. None of the treatments caused any significant reduction in cotton yields. In some instances yields were increased when the herbicides were used.

An experiment similar to those with cotton was conducted with soybeans in 1967 at Perkins. Application and incorporation of the herbicides were made 92, 65, 37, and 15 days prior to the planting of soybeans on June 8. Moisture conditions subsequent to application of the herbicides were considered good. The plots were four rows wide by 50 feet long replicated four times. Plots treated with all herbicides were cross disked for incorporation. The area was then left alone until such time as planting could be done, and the entire experiment planted at the same time.

Nitralin and trifluralin controlled both grass and broadleaf weeds very satisfactorily when applied at any interval up to 92 days before planting (Table 4). Hoe times for these treatments were not significantly different from each other at any time within the experiment. Propachlor did not perform satisfactorily when incorporated at any interval prior to planting, even 15 days. It is apparent from this experiment and other work which has been conducted that propachlor should not be deeply incorporated, but probably should best be applied as a preemergence

Table 2—Effect of Time (in days) Between Herbicide Incorporation and Planting of Cotton on Control of Grass and Broadleaf Weeds, 1966 and 1967.

Herbicide	Rate lb/A	Percent Grass Weed Control									Percent Broadleaved Weed Control								
		81 Days			50 Days			21 Days			81 Days			50 Days			21 Days		
		'66	'67	Av.	'66	'67	Av.	'66	'67	Av.	'66	'67	Av.	'66	'67	Av.	'66	'67	Av.
Trifluralin	¾	100	100	100	100	100	100	100	100	100	90	90	90	100	90	95	100	90	95
"	1½	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Nitralin	¾	100	100	100	100	90	95	100	100	100	100	90	95	90	80	85	100	100	100
"	1½	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Fluometuron	1	80	60	70	100	80	90	100	90	95	80	60	70	100	90	95	100	80	90
"	2	100	90	95	100	80	90	100	80	90	100	100	100	100	90	95	100	100	100
Prometryne	2	90	50	65	90	70	80	100	100	100	100	40	70	100	50	75	90	100	95
"	3	90	70	80	100	80	90	100	100	100	80	80	80	100	80	90	100	90	95
Check	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3— Effect of Time (in days) Between Herbicide Incorporation and Planting of Cotton on the Control of Weeds (As measured by hoe times) and Cotton Yields, 1966 and 1967.

Herbicide	Rate lb/A	Hoe Time (Hours/A)									Yield (pounds lint per acre)								
		81 Days			50 Days			21 Days			81 Days			50 Days			21 Days		
		'66	'67	Av.	'66	'67	Av.	'66	'67	Av.	'66	'67	Av.	'66	'67	Av.	'66	'67	Av.
Trifluralin	¾	2.0	2.0	2.0	0.9	1.7	1.3	1.3	1.1	1.2	611	832	722	917	998	958	780	892	836
"	1½	1.8	0.8	1.3	1.0	1.7	1.4	1.0	0.7	0.9	740	701	721	867	862	865	792	925	859
Nitralin	¾	1.9	1.2	1.6	1.7	2.9	2.3	0.9	0.7	0.8	717	845	781	888	886	887	925	959	942
"	1½	1.5	0.7	1.1	1.1	1.5	1.3	1.2	0.6	1.4	716	814	765	853	914	884	856	967	912
Fluometuron	1	4.5	5.9	5.2	1.3	2.0	1.7	1.6	2.2	1.9	568	806	687	900	1044	972	886	846	866
"	2	1.4	1.0	1.2	1.5	2.5	2.0	0.9	0.7	0.8	635	835	735	856	883	870	759	785	772
Prometryne	2	3.4	15.5	9.5	1.8	6.3	4.1	1.4	3.0	2.2	596	978	787	860	883	872	890	955	923
"	3	3.3	4.2	3.8	1.2	1.8	1.5	0.9	0.7	0.8	609	866	738	852	987	920	864	952	908
Check	--	7.5	17.7	12.6	7.5	17.7	12.6	7.5	17.7	12.6	560	771	666	935	771	853	948	771	860

treatment (rather than a preplant treatment). It seems to provide much more satisfactory weed control when used preemergence.

An experiment was conducted at Stillwater in 1967 on the incorporation of propazine and propachlor in grain sorghum. Again the herbicides were applied 45 days, 29 days, and 13 days prior to the planting of the sorghum, and incorporated with the tractor tiller. In addition, a preemergence treatment was made immediately after the planting of the sorghum. Moisture conditions were good for all the treatments including the preemergence treatment. Table 5 shows the amount of weed control and the hoe times per acre. As was pointed out in the soybean experiment, propachlor does not perform satisfactory as an incorporated treatment. When applied preemergence the weed control was quite satisfactory. Propazine provided some weed control when incorporated into the soil, particularly if incorporated only 13 days prior to treatment. Broadleaf weed control was considerably better than the grass weed control. In these studies when propazine was incorporated 29 or 13 days prior to planting at the high rate the general weed control was better than when the same herbicide was used as a preemergence treatment. In these experiments the high rate of propazine could be incorporated long before planting and provide good weed control.

Depth of Incorporation

Experiments were established in 1965 and 1967 to determine the optimum depth of incorporation of trifluralin and vernolate. Cotton plots were treated with trifluralin incorporated at different depths (0, 1, 2, and 3 inches) in both years as were peanuts treated with vernolate. In addition, peanuts were treated with trifluralin incorporated at the four different depths in 1965 only. The 0 inch depth was applied immediately after planting as a preemergence treatment so that the herbicide remained on the surface of the soil. The other treatments were applied immediately prior to planting and incorporated with a power roto tiller set for the desired depth. The soil type was a Norge sandy loam. Each herbicide was applied at three rates at each of the incorporation depths.

The activity of the vernolate was greatly improved by incorporation and was directly related to the depth of incorporation and the rate of herbicide application (Table 6). Very little crop injury was noted even at the highest herbicide rate. The degree of weed control improved as the depth of incorporation increased whether measured by percent control of the weeds or by the hoe time necessary to clean up the plots. Even when applied as a surface treatment the weed control was far superior to the untreated plots.

Table 4 — Effect of Time (in days) Between Herbicide Incorporation and Planting Soybeans on Weed Control.

Herbicide	Rate lb/A	Percent Grass Weed Control				Percent Broadleaved Weed Control				Hoe Time (hr/A)*			
		92 Days	65 Days	37 Days	15 Days	92 Days	65 Days	37 Days	15 Days	92 Days	65 Days	37 Days	15 Days
Propachlor	4	30	30	30	10	40	30	10	10	10.9ab	10.4ab	10.1ab	12.4a
"	6	20	30	30	60	30	40	30	40	12.3a	9.6ab	7.8b	9.7ab
Nitralin	¾	90	100	100	100	90	100	100	90	1.9c	0.8c	0.8c	0.8c
"	1½	100	100	100	100	100	100	100	100	0.5c	0.8c	0.8c	0.7c
Trifluralin	¾	90	100	80	100	90	100	80	90	1.0c	0.8c	0.8c	1.0c
"	1½	100	100	100	100	90	100	100	100	0.8c	0.8c	0.8c	0.9c
Check	--	0	0	0	0	0	0	0	0	11.8a	11.3a	7.7b	11.7a

* Numbers followed by the same letter not significantly different from each other at the 5% level.

Table 5 — Effect of Time (in days) Between Herbicide Incorporation and planting Sorghum on Weed Control, 1967.

Herbicide		Percent Grass Weed Control				Percent Broadleaved Weed Control				Hoe Time (hr/A)			
		45 Days	29 Days	13 Days	Pre-e	45 Days	29 Days	13 Days	Pre-e	45 Days	29 Days	13 Days	Pre-e
Propazine	1½	30	35	40	60	85	90	85	90	6.7	9.6	9.3	8.0
"	3	70	85	85	85	95	95	100	85	5.6	2.7	3.7	6.8
Propachlor	3	10	10	15	90	5	5	0	80	12.4	10.3	10.5	3.2
"	4	10	5	10	85	5	5	0	75	13.1	12.0	14.4	2.6
Check	-	0	0	0	0	0	0	0	0	11.9	11.9	11.9	11.9

Table 6—Influence of Depth of Incorporation on Peanuts and Weeds Treated with Vernolate, 1965 and 1967.

Herbicide Rate (lb/A)	Incorp. Depth	Crop Injury Rating	% Weed Control		Hoe Time (Hr/A)	Yield (1965)	(lb/A) 1967
			Grasses	Broadlvs.			
2	0"	0	70	50	5.0	1200	1249
"	1	1	85	70	2.6	997	1117
"	2	1	85	70	2.5	1200	1162
"	3	1	95	85	1.3	1132	1127
3	0"	0	65	40	5.3	1110	1286
"	1	2	90	85	1.8	1178	985
"	2	1	95	90	1.8	997	1064
"	3	1	95	95	1.2	974	1096
4	0"	0	85	65	2.7	1110	1090
"	1	1	100	85	2.0	1019	932
"	2	2	95	95	1.5	1132	1122
"	3	1	100	100	1.0	1064	1241
0	-	0	0	0	0	1109	----

The weed control obtained with trifluralin in both cotton and peanuts was drastically improved by incorporation (Table 7). Surface treatments provided some weed control consistently superior to the check. However, as the depth of incorporation increased from one to three inches the weed control improved, particularly noticeably when measured by the hoe times. Weed control was better at the high rates than at the half pound rate as this was a loam soil. Surprisingly, little crop injury was noted with trifluralin at any rate or any depth of incorporation. However, there was a yield reduction at the high rate of trifluralin application to peanuts when there was no incorporation. Incorporation to a depth of three inches of the high rate did not reduce peanut yields. Although the rate is three times the maximum recommended for normal use in peanuts, the soil that was being used was a heavier soil than is normally used for peanut growing.

Method of Incorporation

Edwards (2), Burnside (1), and Robinson (5), all found a power tiller to be the best tool for incorporating trifluralin. The broadcast rotary hoe and the section harrow were similar in how well they incorporated the herbicide. Incorporation at depths of 2 to 3 inches did not affect plant growth or population. Kapusta did not find this to be true (3).

Four different herbicides were applied prior to the planting of either cotton or peanuts at different locations in Oklahoma. In each

Table 7—Effect of Depth of Incorporation on Cotton, Peanuts and Weeds Treated with Trifluralin in 1965.

Herbicide Rate (lb/A)	Incorp. Depth	Crop Injury Rating	% Weed Control		Hoe Time (Hr/A)	Yield lb/A
			Grasses	Broadlvs.		
Cotton Crop						
½	0″	0	60	45	5.8	542
″	1	0	75	60	3.5	487
″	2	1	90	90	2.0	471
″	3	0	90	90	1.6	493
1	0″	0	75	55	4.0	503
″	1	1	90	80	2.3	454
″	2	1	95	90	1.5	340
″	3	1	100	95	1.5	478
1½	0″	1	85	80	2.9	460
″	1	1	95	90	1.6	383
″	2	1	100	95	1.3	487
″	3	0	100	100	1.1	460
0	–	0	0	0	11.6	443
Peanut Crop						
½	0″	2	80	60	4.4	1224
″	1	0	100	80	3.0	1155
″	2	1	100	90	2.7	1110
″	3	1	100	90	2.3	1223
1	0″	1	70	40	3.9	1133
″	1	0	100	90	3.1	1314
″	2	1	80	80	3.1	1246
″	3	1	100	90	1.0	1223
1½	0″	0	60	60	4.2	997
″	1	0	100	90	1.9	1042
″	2	1	100	100	1.1	1065
″	3	1	100	100	0.6	1133
0	–	0	0	0	12.2	1178

instance after application the herbicides were incorporated with either a ground driven rotary hoe, a tandem disk, or a flexible spring tooth harrow. Immediately after incorporation the crops were planted in the usual method.

Trifluralin was applied on three different soil types at different locations in the state and then incorporated with each of the three tools. Table 8 shows some of the weed control data that was obtained. There was considerable variation between the different soil types and the degree of weed control obtained with the incorporation tools. In 1966 all three tools seemed to have incorporated the herbicide about as well on both silt loam and clay loam soils. However, in 1967 this was not true. In 1967 tandem disk incorporation of trifluralin provided the best weed control in all instances, regardless of soil variations. On the silt loam soil there was not as much difference between the incorporation tools

Table 8 — Effect of Three Methods of Incorporating Trifluralin on Weed Control in Different Soil Types, 1966-1967.

Rate lb/A	Soil Type	Method of Incorporation	1966 % Weed Control Grass	1966 % Weed Control Brlvs*	1966 Hoe Time (Hr/A)	1967 % Weed Control Grass	1967 % Weed Control Brlvs*	1967 Hoe Time (Hr/A)	Average % Weed Control Grass	Average % Weed Control Brlvs*	Average Hoe Time (Hr/A)
½	Sandy Loam	Rotary Hoe	50	60	--	50	90	3.4	50	75	--
"	"	Disc	80	80	--	90	80	0.8	85	80	--
"	"	Spring Tooth	80	60	--	70	80	3.0	75	70	--
¾	Silt Loam	Rotary Hoe	90	70	3.4	100	90	1.1	95	80	2.2
"	"	Disc	90	90	3.4	90	90	0.8	90	90	2.1
"	"	Spring Tooth	90	90	2.3	70	70	1.9	80	80	2.1
1	Silt Loam	Rotary Hoe	100	70	3.6	70	70	1.4	85	70	2.5
"	"	Disc	100	80	3.4	90	90	0.8	95	85	2.2
"	"	Spring Tooth	80	90	2.3	80	80	1.0	80	85	1.5
¾	Clay Loam	Rotary Hoe	--	--	--	70	10	21.4	--	--	--
"	"	Disc	--	--	--	100	70	6.6	--	--	--
"	"	Spring Tooth	--	--	--	80	30	14.7	--	--	--
1	Clay Loam	Rotary Hoe	--	--	2.2	70	20	19.8	--	--	11.0
"	"	Disc	--	--	1.1	90	80	4.8	--	--	3.0
"	"	Spring Tooth	--	--	2.0	80	70	17.7	--	--	9.8

*"Brlvs" means broad leaf weeds.

as there was on the sandy loam or clay soils. On the clay loam soil, particularly, there was a striking improvement in weed control when the tandem disk was used for incorporation. In 1967 the experiment was also established on a loam soil at rates of ¾ and 1 lb/A. The results were somewhat similar to those found on the clay loam soil but the hoe times were not quite as widely spread. On the loam soil the high rate of trifluralin masked method of incorporation differences. At the ¾ of a pound per acre rate, however, the disk was superior to the spring tooth harrow, which was significantly better than the rotary hoe for incorporation. On the lighter soils there was less difference between incorporation tools than on the heavy soils.

Wider differences between the various incorporation tools were also noted for nitralin in 1967 when compared with 1966 (Table 9), On silt loam and sandy loam soils disk incorporation was not particularly superior to the other methods of incorporation. However, on the clay loam soil disk incorporation was significantly better than the other method of incorporation, and there was no large difference between the rotary hoe and the spring tooth harrow. This was also found to be true on a loam soil, although on the loam the spring tooth was somewhat better than the rotary hoe for nitralin incorporation.

Prometryne and fluometuron were also incorporated in 1966 and 1967 with the three incorporation tools on a silt loam soil. With these herbicides no single incorporation tool seemed to be consistently better than any other (Table 10). In general, shallow incorporation with tools other than the tandem disk seemed to do a somewhat better job of weed control, although this was not always true. Prometryne and fluometuron are generally used as preemergence herbicides. Thus, shallow incorporation of these two herbicides might be expected to be more effective than with more volatile herbicides such as nitralin and trifluralin. For the latter two herbicides the disk appears to be the most consistently reliable incorporation tool of the three used.

Gallonage of Carrier for Trifluralin and Nitralin

An experiment was established in 1967 to see if lower amounts of carrier could be used in applying trifluralin and planavin. Plots were treated on May 25 and then planted on June 15. After treatment they were incorporated two inches deep with the tractor roto-tiller. Different gallonages were achieved by using different sized nozzle tips in the boom of the experimental plot tractor sprayer.

The results of this experiment are shown in Table 11. Since this is only one year's data the results are somewhat preliminary, but they

Table 9—Effect of Three Methods of Incorporating Nitralin on Weed Control in Different Soil Types, 1966 and 1967.

Rate lb/A	Soil Type	Method of Incorporation	1966 % Weed Control Grass	1966 % Weed Control Brlvs*	1966 Hoe Time (Hr/A)	1967 % Weed Control Grass	1967 % Weed Control Brlvs	1967 Hoe Time (Hr/A)	Average % Weed Control Grass	Average % Weed Control Brlvs	Average Hoe Time (Hr/A)
½	Sandy Loam	Rotary Hoe	50	40	--	70	70	3.4	60	55	--
"	"	Disc	40	50	--	80	90	3.3	60	70	--
"	"	Spring Tooth	40	40	--	60	90	2.4	50	65	--
¾	Silt Loam	Rotary Roe	90	80	2.1	60	60	2.8	75	70	2.5
"	"	Disc	80	70	3.9	50	80	1.8	65	75	2.7
"	"	Spring Tooth	70	60	5.7	80	70	1.3	75	65	3.5
1	Silt Loam	Rotary Hoe	90	90	2.3	60	70	2.4	75	80	2.3
"	"	Disc	90	90	2.9	50	60	4.4	70	75	3.6
"	"	Spring Tooth	90	80	2.9	40	60	2.7	65	70	2.8
¾	Clay Loam	Rotary Hoe	--	--	--	80	30	19.6	--	--	--
"	"	Disc	--	--	--	80	50	5.7	--	--	--
"	"	Spring Tooth	--	--	--	80	20	20.5	--	--	--
1	Clay Loam	Rotary Hoe	--	--	8.1	80	20	20.9	--	--	14.5
"	"	Disc	--	--	4.3	90	60	7.6	--	--	6.0
"	"	Spring Tooth	--	--	6.4	70	20	16.2	--	--	11.3

Table 10—Effect of Three Methods of Incorporating Prometryne and Fluometuron in a Silt Loam Soil 1966 and 1967.

Rate lb/A	Method of Incorporation	1966 % Control Grass	1966 % Control Brlvs	1966 Hoe Time (Hr/A)	1967 % Control Grass	1967 % Control Brlvs	1967 Hoe Time (Hr/A)	Average % Control Grass	Average % Control Brlvs	Average Hoe Time (Hr/A)	Average % Control All
					Prometryne						
2½	Rotary Hoe	40	40	4.7	80	80	1.1	60	60	2.9	60
"	Disc	20	60	5.2	60	90	1.6	40	75	3.4	57
"	Spring Tooth	100	90	2.3	70	80	2.6	85	85	2.4	85
3½	Rotary Hoe	60	60	3.5	80	100	0.9	70	80	2.2	75
"	Disc	50	60	6.1	60	90	1.6	55	75	3.8	65
"	Spring Tooth	90	90	3.8	70	90	0.9	80	90	2.4	85
					Fluometuron						
1½	Rotary Hoe	90	70	3.6	30	70	4.4	60	70	4.0	65
"	Disc	90	70	4.0	30	50	7.7	60	60	5.8	60
"	Spring Tooth	70	80	4.2	60	70	1.8	65	75	3.0	70
2½	Rotary Hoe	90	80	2.3	90	100	0.7	90	90	1.5	40
"	Disc	70	80	2.0	40	70	3.6	55	75	2.8	65
"	Spring Tooth	60	80	4.3	40	40	3.4	50	60	3.8	55

Table 11—The Effect of Carrier Gallonage on the Activity of Trifluralin and Nitralin, 1967.

Herbicide	Rate lb/A	Percent Grass Control Gallons Per Acre 1	2½	5	10	20	Percent Brlv. Control Gallons Per Acre 1	2½	5	10	20	Hoe Time (Hr/A) Gallons Per Acre 1	2½	5	10	20
Trifluralin	½	50	80	90	70	90	40	70	90	70	70	5.0	3.0	2.0	4.4	1.4
"	¾	50	80	100	100	100	50	80	90	70	90	5.5	4.5	2.3	3.5	2.2
Nitralin	½	100	90	90	70	80	80	80	60	70	70	2.4	2.7	3.2	4.4	2.6
"	¾	100	100	80	80	90	80	80	80	80	80	2.6	3.6	3.5	3.4	2.8
Check	–	0	0	0	0	0	0	0	0	0	0	7.2	7.2	7.2	7.2	7.2

are still interesting. Trifluralin seemed to be affected more by variation in gallonage than did nitralin. Nitralin performed equally well at all gallonages involved, whether measured by percent weed control or by hoe time. Trifluralin did not seem to express its full potential for controlling the weeds unless at least five gallons of water per acre were used as carrier. On the basis of the hoe time data, 20 gallons per acre would still be preferable but the percent control data indicates five gallons might be sufficient.

Incorporated vs. Preemergence Use of Some Newer Herbicides

Experiments were established at several locations in which new potentially useful chemicals were compared for herbicidal activity. Since they are new materials their performance under incorporated conditions is often not known.

Results of some of these comparisons are shown in Table 12. The method of usage had no particular influence on crop phytotoxicity, except for the very high rate of C-6313. Most of these potential herbicides performed better as preemergence treatments. Propachlor controlled grasses slightly better when incorporated but in general was superior used preemergence. CP-50144 was effective both ways, but again was

Table 12—Comparison of Preplant Incorporated (Inc.) vs. Preemergence Use (Pre-E) of Several Herbicides*

		Crop Injury		% Weed Control				Hoe Times (Hr/A)		No. of
				Grass		Broadleave				
Herbicides	lb/A	Inc	Pre-e	Inc	Pre-e	Inc	Pre-e	Inc	Pre-e	Expts.
Propachlor	3	0	0	61	56	66	64	14.0	11.4	5
"	4	0	0	80	70	78	77	6.6	7.4	5
C-6989	2	0	1	36	49	39	61	16.4	10.3	6
"	3	0	1	45	40	54	75	11.5	12.6	4
"	4	1	3	54	50	55	59	7.9	5.4	4
UC-22463	4	0	0	75	93	63	87	6.0	4.1	4
"	6	1	1	75	92	65	97	4.2	4.0	4
CP-50144	1	0	0	78	65	75	58	8.0	6.6	3
"	2	0	0	87	85	85	88	4.4	3.1	3
C-6313	2	1	0	45	62	40	82	13.2	8.0	3
"	3	1	0	65	71	78	87	8.0	6.6	3
"	4	5	1	73	80	83	100	6.0	2.8	2
Sindone B	1½	1	0	68	48	55	43	--	--	2
"	2	0	0	75	58	68	53	6.5	8.8	3
"	3	1	2	78	38	78	48	--	--	2
"	4	0	0	83	58	70	57	4.4	8.0	3
Check	-	0	0	0	0	0	0	20.2	20.2	5

*Only locations where there were direct "inc" vs. "pre-e" comparisons are used.

slightly superior preemergence. Sindone B was the only exception to the trend, resulting in better weed control when used as an incorporated herbicide.

Summary

Experiments were conducted to determine how several herbicides may be used when incorporated into the soil. The interval between incorporation and planting of a crop was critical with some herbicides. Trifluralin and nitralin could be incorporated up to at least 81 days prior to planting and still provide good weed control. This was also true of fluometuron at 2 lb/A, but not at one. Prometryne was most satisfactory when used no more than 21 days prior to planting. Propazine could be incorporated up to two weeks before planting, but propachlor should not be incorporated prior to planting.

The activity of vernolate was greatly improved by incorporation and was directly related to the depth of incorporation. The activity increased as the depth of incorporation increased from 0 to 3 inches. This was also true of trifluralin. Preliminary studies were also conducted on the gallonage of carrier needed for trifluralin and nitralin. Gallonage did not appear to influence the activity of nitralin, but gallonages below 5 gpa reduced the degree of weed control obtained from trifluralin. Several newer herbicides were found to perform better preemergence than incorporated. Sindone B was the only exception to this.

The tandem disc, spring tooth harrow and rotary hoe were compared as to their effectiveness for incorporating four herbicides. There was considerable variation between different soil types and the degree of weed control obtained with the incorporation tools. In 1966 there was less difference between tools than in 1967. Generally tandem disc incorporation of trifluralin and nitralin provided the best weed control, regardless of soil type. The spring tooth was better than the rotary hoe. With prometryne and fluometuron no single incorporation tool was consistently better than any other. In general, shallow incorporation with tools other than the tandem disc seemed to provide somewhat better weed control, but this was not always true.

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