TOLERANCE OF SEVERAL SOUTHERN TURFGRASSES TO VARIOUS SPRAY OILS[1]

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ABSTRACT

A split-split plot design was used to evaluate the effects of 7 oils on 10 warm season turfgrasses. Oils were main-plots, rates of oils sub-plots and repeat applications of oils sub-sub-plots.

All of the grasses evaluated tolerated all of the oils at low rates. As the rate of oil was increased, the amount of damage increased on all grasses. The repeat applications further added to the damage.

One month after the last treatment was applied, damage symptoms from the highest rates of oil had disappeared. A rate of 2 gpa of oil could be safely sprayed on any of the turf species in the experiment without turf damage.

INTRODUCTION

Various hydrocarbons such as mineral spirits, gasoline, kerosene, fuel oil and diesel oil have been used as nonselective herbicides in various agricultural crops (1,2,3,4,5 and 6). High rates of these oils used alone and in combination with preemergence herbicides increased rate of top kill in addition to controlling germinating weed seed.

Klingman (2) found that some weeds were tolerant to certain oils and that aromatic oils were more toxic to plants than olefin oils. Straight chain paraffin oils were least toxic. Wiese (7) first reported in 1966 an increase in postemergence weed control in sorghum when atrazine, propazine or diuron were mixed with 2 or 40 gpa of non-toxic oils.

The objects of these experiments were to determine the tolerance of 10 commonly used southern turfgrasses to 7 non-toxic oils applied in both summer and winter at various rates.

METHODS AND MATERIALS

Twenty experiments were used to evaluate tolerance of 10 warm-season turfgrasses to 7 spray oils applied in both summer and winter. Grasses included in these experiments were: 'Argentine' bahia; common, 'Bayshore,' 'Everglades,' 'Ormond,' 'Tiflawn' and 'Tifway' bermudas; centipede; 'Emerald' zoysia and 'Bitterblue' St. Augustine. Each of these 10 grasses was handled as a separate experiment, treated in November-December, 1964 ad retreated again in August, 1965, with the following oils: SS TS (X-419-130), SS 38 (X-419-131), SS 91 (X-419-132), SSP 7 (X-419-133), SSP 11 (X-419-134), SSP 16 (X-419-135) and SFC 100 (X-419-100). Hereafter, in this paper, each oil will be referred to without code numbers in parenthesis.

Each experiment was a split-split-plot design with oils as main-plots, rates as sub-plots and repeat applications as sub-sub-plots. A 10′ x 30′ block of grass was divided into 3 replications, each 10′ x 9′ with a 1′ x 10′ alley between each replication.

Seven oils and 1 check made up the main plots which were 4′ x 3′, except the checks, which were 2′ x 3′.

Four rates of each oil were used as sub-plots. Each sub-plot was 1′ x 3.′ Oil rates used were 1, 2, 4 and 8 gallons per acre (gpa).

Sub-sub-plots were initial applications (X) of 1, 2, 4 and 8 gpa oil and repeat applications after 1 week (2X) and 2 weeks (3X) using 1, 2, 4 and 8 gpa of oil each repeat application. Sub-sub-plots receiving the 2X treatments received 2, 4, 8 and 16 gpa of oil within an 8-day period. Those receiving 3X treatments received 3, 6, 12 and 24 gpa of oil within the 15-day period of treatment.

Oils were first added to the 10 grasses on November 17, 1964. Repeat sub-sub-plot applications were made November 24 and December 1, 1964. Average daily temperature during treatment period was 76.5° F. These first experiments were terminated December 31, 1964 after all symptoms of phytotoxicity had disappeared. The same grasses were again treated, as described above, beginning July 30, 1965 when the average daily temperature, during the treatment period, was 91° F. Identical rates and repeat treatments using the same oils were again used on the same grasses. All visible effects from previous treatments had long since vanished. The second series of experiments were termi-

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nated September 15, 1965 after all symptoms of oil phytotoxicity had disappeared.

Measured amounts of each oil were diluted to 2 gallons with tap water. The oil-water emulsion was stirred and poured into a 3-gallon stainless steel pressure sprayer equipped with a single 8004 TeeJet nozzle. Pressure and walking speed were adjusted to deliver 40 gpa of the oil-water emulsion. The spray tank was thoroughly cleaned between each oil treatment.

Year around maintenance of the grasses included fertilizing with 20 pounds per 1000 square feet of a 6-6-6 in March and October and monthly applications of N at the rate of 1 pound per 1000 square feet in the form of ammonium nitrate. Grasses were mowed weekly at recommended heights and insect, disease and nematode control measures practiced as needed.

Phytotoxicity ratings were the only data taken. These ratings were from 9 (no phytotoxic effects to the grass) to 1 (complete kill of the grass blades). Maximum damage occurred 3 days after each spraying; therefore, all plots were rated 3 days following each application or re-application of oils. The first rating was made 3 days after the initial application of oils, the second rating after 10 days and the third after 17 days. All plots were rated at each date, therefore, at the first rating only X sub-sub-plots had been treated. At the second rating date, plots receiving the initial application X and those receiving the first repeat application 2X were rated. At this point, the 2X and 3X plots had received the same rates of oils and received the same ratings. The second rating date was after the initial application had been on for 10 days and the first repeat application only 3 days. The third ratings included X, 2X and 3X repeat applications which had been applied 17, 10 and 3 days prior to rating, respectively. The maximum effect from the oils was expected from the 3X re-applications because of the increased oil rates and the proximity of the last rating to the last re-treatment.

An analysis of variance was made on each grass each season according to the accepted procedure for analyzing a split-split-plot. Data from the 'Argentine' bahiagrass experiment was analyzed with season of application being the main-plots and oils the sub-plots. Data combining the effects of all oils, all rates and repeat application on all grasses are not supported by statistical analysis, however, the very large number of treatments that made up these means and supporting statistics for the individual experiments give some support to the conclusions reported.

Table 1. AVERAGE EFFECTS OF ALL TREATMENT DATES AND RATES OF OILS ON APPEARANCE RATINGS[1] OF ARGENTINE BAHIAGRASS

Initial Rate	Repeat Applications		Treatment Dates	
			Nov-Dec	Aug
X	2 X	3X	1964	1965
gpa	gpa	gpa	Avg. of X+2X+3X	
1	2	3	6.6	8.8
2	4	6	6.5	8.6
4	8	12	6.2	8.1
8	16	24	5.8	7.4
Checks	-	-	7.1	9.0
LSD:		.05	.01	
Date means		NS	NS	
Rate means		.21	.35	

[1]Rating scale - 9 = No toxicity to 1 = Complete kill

Results and Discussion

Comparison of 'Argentine' bahiagrass data from the November-December 1964 experiment with data from the August 1965 experiment showed no differences in phytotoxicity ratings, (Table 1). Since phytotoxicity was the same for both experiments, only the August experiment will be discussed, using 'Argentine' bahiagrass data. A comparison of oil treatment and check averages showed that oils damaged grass slightly, (Table 2). 'Emerald' zoysia, St. Augustine, 'Ormond' and centipede grasses tolerated oils better than other grasses.

Table 2. AVERAGE EFFECTS OF ALL OILS AT ALL RATES AND COMBINATIONS OF RATES ON APPEARANCE RATINGS[1] OF 10 SOUTHERN TURFGRASSES THREE DAYS AFTER THE FINAL SPRAYING, AUGSUT, 1965

Turfgrass	Treat. Means
Argentine bahiagrass	8.15
Common bermudagrass	7.92
Bayshore bermudagrass	7.90
Everglades germudagrass	8.15
Ormond bermudagrass	8.32
Tiflawn bermudagrass	7.93
Tifway bermudagrass	7.88
Centipedegrass	8.42
Emerald zoysiagrass	8.47
St. Augustinegrass	8.46
Checks	9.00

[1]Rating scale - 9 = No toxicity to 1 = Complete kill

One application (X) of oil at all rates had little toxic effect on any of the grasses, (Table 3). Eight gpa of SS TS oil produced the lowest appearance rating (8.2) from a single application of oil. The 8.2 rating was the result of a very slight discoloration that lasted approximately 5 days. Twenty-four gpa of SS TS oil (8 gpa applied 3 times at weekly intervals) resulted in severe damage to all grasses, (Table 3). All plots sprayed 3 times within 3 weeks (3X) were damaged more than those sprayed once (X) or twice (2X), (Table 3). Results indicate damage increased as soil rates were increased. One month following treatment,

TABLE 3. THE EFFECTS OF ALL OIL TREATMENTS ON APPEARANCE RATINGS OF TEN SOUTHERN TURFGRASSES SPRAYED ONE TIME (X), TWO TIMES (2X) AND THREE TIMES (3X) THE RATE SHOWN BELOW

Treatment No.	Type of Oil	Initial Rate (X)	Times each plot sprayed		
			X	2X	3X
		gpa			
1.	SS TS[1]	1	9.0	9.0	8.7
2.	SS TS	2	9.0	8.7	7.5
3.	SS TS	4	8.9	8.0	5.9
4.	SS TS	8	8.2	6.3	3.2
5.	SS 38[1]	1	9.0	8.9	8.2
6.	SS 38	2	9.0	8.7	7.3
7.	SS 38	4	8.9	8.2	6.2
8.	SS 38	8	8.5	5.7	4.4
9.	SS 39[1]	1	9.0	8.9	8.3
10.	SS 91	2	8.9	8.8	7.8
11.	SS 91	4	8.9	7.9	6.1
12.	SS 91	8	8.8	6.9	5.0
13.	SSP7[2]	1	9.0	8.9	8.5
14.	SSP7	2	9.0	8.8	7.8
15.	SSP7	4	8.8	8.6	7.0
16.	SSP7	8	8.8	7.8	5.6
17.	SSP 11[2]	1	9.0	9.0	8.7
18.	SSP 11	2	9.0	9.0	8.1
19.	SSP 11	4	9.0	8.8	7.4
20.	SSP 11	8	8.9	8.0	6.1
21.	SSP 16[2]	1	9.0	8.9	8.6
22.	SSP 16	2	9.0	8.9	8.1
23.	SSP 16	4	8.9	8.6	7.4
24.	SSP 16	8	8.9	8.3	6.7
25.	SFC 100[3]	1	8.9	8.8	8.5
26.	SFC 100	2	8.9	8.7	8.1
27.	SFC 100	4	8.9	7.8	7.0
28.	SFC 100	8	8.5	7.1	5.5
29.	Check	-	9.0	9.0	9.0

1 Naphthenic oils
2 Paraffin oils
3 Wax emulsion

plots receiving the highest rate of oil (8 gpa per application—3 times at weekly intervals) had appearance ratings equal or superior to the checks.

One and 2 gpa rates of all oils produced only slight phytotoxic effects to the grasses even when the 1 and 2 gpa rates were re-applied after 7 and 14 days. Higher rates of 4 and 8 gpa produced more toxicitiy symptoms than lower rates, (Table 4).

Different oils produced slightly different phytotoxic effects with SS TS oil being most toxic and SSP 16 and SSP 11 least toxic. SSP 11 is presently marketed as Sunspray 11E oil and is used for control of certain pests in citrus.

Increasing oil rates reduced quality ratings for all grasses, which were lowest on plots receiving 24 gpa (3 weekly applications of 8 gpa), (Table 5). SS TS oil was the most toxic at all rates.

Table 5. AVERAGE APPEARANCE RATINGS[1] OF 10 SOUTHERN TURFGRASSES TREATED WITH VARIOUS OILS AT ALL RATES, AUGUST 1965

Oil	Appearance Ratings
SS TS	7.7
SS 38	7.8
SS 91	8.0
SSP 7	8.2
SSP 11	8.4
SSP 16	8.5
SFC 100	8.1
Checks	9.0

[1]Rating scale - 9 = No toxicity to
1 = Complete kill

'Argentine' Bahiagrass Data

Because of the size and number of complete tables involved, and since the oil and rate responses were very similar for all 10 grasses, only the 'Argentine' bahiagrass data will be discussed, (Table 7). Comparison of data between November-December 1964 and August 1965 treatments showed no significant differences between dates, (Table 8). All rates of oils were more toxic than checks in both 1964 and 1965. All differences between rates were significant at the 1 percent level of probability except the low rate in August 1965 which was significant at the 5 percent level of probability. Increased toxicity of oils in November-December 1964 was probably due to reduced vigor of grass already weakened by two light frosts during the treat-

Table 4. AVERAGE APPEARANCE RATINGS[1] OF 10 SOUTHERN TURFGRASSES TREATED INITIALLY WITH 4 RATES OF VARIOUS OILS AND TWO REPEAT APPLICATIONS USING SAME RATES, AUGUST 1965

Initial Rate X	Total Oil Added By Repeat Treatments After 7 days 2X	After 14 days 3X	Appearance Ratings
gpa	gpa	gpa	
1	2	3	8.8
2	4	6	8.5
4	8	12	8.0
8	16	24	7.1
Checks			9.0

[1]Rating scale - 9 = No toxicity to
1 = Complete kill

TABLE 6. AVERAGE EFFECTS OF ALL OIL TREATMENTS ON APPEARANCE RATINGS[1] OF TEN SOUTHERN TURFGRASSES RATED THREE DAYS AFTER THE FINAL SPRAYING AUGUST, 1965

(9=No phytotoxic effect to 1=Grass blades killed)

Treatment	Final Rate gpa	Toxicity Ratings
SS TS	3	8.9
SS TS	6	8.4
SS TS	12	7.6
SS TS	24	5.9
SS 38	3	8.7
SS 38	6	8.3
SS 38	12	7.8
SS 38	24	6.5
SS 91	3	8.8
SS 91	6	8.6
SS 91	12	7.7
SS 91	24	6.9
SSP 7	3	8.8
SSP 7	6	8.5
SSP 7	12	8.2
SSP 7	24	7.4
SSP 11	3	8.9
SSP 11	6	8.7
SSP 11	12	8.4
SSP 11	24	7.7
SSP 16	3	8.8
SSP 16	6	8.7
SSP 16	12	8.3
SSP 16	24	8.0
SFC 100	3	8.8
SFC 100	6	8.6
SFC 100	12	7.9
SFC 100	24	7.1
Check	0	9.0

[1]Rating Scale - 9 = No toxicity to 1 = Complete kill

TABLE 7. APPEARANCE RATINGS[1] OF ARGENTINE BAHIAGRASS AFTER WEEKLY SPRAYINGS USING SUN OILS AT RATES OF 1, 2, 4 OR 8 GALLONS PER ACRE. RATINGS WERE TAKEN 3 DAYS FOLLOWING EACH SPRAYING. REPEAT SPRAYINGS OF EACH OF THE FOUR RATES WERE MADE OVER TWO-THIRDS OF EACH TURF PLOT (2X) ONE WEEK AFTER THE INITIAL SPRAYING. ONE WEEK AFTER THE SECOND SPRAYING REPEAT SPRAYINGS WERE MADE ON THE REMAINING ONE-THIRD OF EACH PLOT (3X).

	Treatment	Rate of Application Gal./A. X	Rating Dates - 1964						Rating Dates - 1965					
			11-20	11-27		12-4			8-2	8-10		8-18		
			1X	1X	2X	1X	2X	3X	1X	1X	2X	1X	2X	3X
1	SS TS (X-419-130)	1	6.3	6.7	5.0	6.3	6.0	5.3	8.7	9.0	8.3	9.0	9.0	8.0
2	SS TS (X-419-130)	2	6.0	6.5	5.3	6.3	6.0	5.3	9.0	9.0	7.7	9.0	8.3	6.7
3	SS TS (X-419-130)	4	6.0	6.0	5.0	6.5	6.3	5.0	9.0	8.0	5.3	9.0	7.0	5.0
4	SS TS (X-419-130)	8	5.3	6.0	4.7	6.5	5.7	4.7	9.0	7.7	3.7	8.7	6.0	3.0
5	SS 38 (X-419-131)	1	6.0	7.0	6.7	6.7	6.0	5.7	9.0	9.0	8.7	9.0	9.0	8.7
6	SS 38 (X-419-131)	2	4.7	6.7	6.7	6.7	6.0	5.7	8.7	9.0	8.3	9.0	8.7	7.0
7	SS 38 (X-419-131)	4	4.7	6.7	5.7	6.3	5.7	4.7	9.0	8.7	7.0	9.0	8.3	5.0
8	SS 38 (X-419-131)	8	6.0	6.3	5.0	6.0	5.3	4.3	9.0	7.0	4.0	9.0	7.0	3.7
9	SS 91 (X-419-132)	1	6.0	7.0	6.7	6.7	6.7	6.7	8.7	9.0	8.3	9.0	9.0	7.7
10	SS 91 (X-419-132)	2	5.7	6.7	6.5	6.7	6.7	6.7	9.0	9.0	8.7	9.0	8.7	7.0
11	SS 91 (X-419-132)	4	5.7	6.5	5.3	6.7	6.7	6.5	8.7	8.0	5.7	9.0	7.7	5.3
12	SS 91 (X-419-132)	8	3.3	6.0	4.7	6.3	5.7	5.5	8.7	8.3	3.7	8.7	7.0	4.7
13	SS P7 (X-419-133)	1	6.3	7.0	6.7	7.0	7.0	7.0	9.0	9.0	9.0	9.0	9.0	9.0
14	SS P7 (X-419-133)	2	7.3	7.0	7.0	7.0	7.0	6.7	9.0	9.0	9.0	9.0	9.0	8.3
15	SS P7 (X-419-133)	4	5.0	7.0	7.0	7.0	7.0	6.3	8.3	8.7	7.7	9.0	9.0	7.7
16	SS P7 (X-419-133)	8	4.7	7.0	6.3	7.0	7.0	6.3	8.7	8.0	6.0	9.0	8.0	7.0
17	SS P11 (X-419-134)	1	5.7	7.0	7.0	7.0	6.7	6.7	8.7	9.0	8.7	9.0	9.0	8.7
18	SS P11 (X-419-134)	2	6.7	6.7	6.7	6.7	6.7	6.7	9.0	9.0	9.0	9.0	9.0	8.3
19	SS P11 (X-419-134)	4	6.3	6.7	6.3	6.7	6.7	6.3	8.7	9.0	8.7	9.0	8.7	7.3
20	SS P11 (X-419-134)	8	3.7	7.0	6.0	6.5	6.7	6.0	8.0	8.0	6.0	9.0	7.0	6.0
21	SS P16 (X-419-135)	1	7.0	7.0	7.0	6.7	6.7	6.7	9.0	9.0	9.0	9.0	9.0	9.0
22	SS P16 (X-419-135)	2	5.3	7.0	6.7	7.0	6.7	6.7	9.0	9.0	9.0	9.0	9.0	8.3
23	SS P16 (X-419-135)	4	5.0	7.0	6.3	7.0	6.5	6.3	8.7	9.0	8.3	9.0	8.7	7.7
24	SS P16 (X-419-135)	8	4.7	6.7	6.3	6.7	6.5	6.0	8.7	8.7	7.3	9.0	8.0	6.3
25	S-F-C 100 (X-419-100)	1	5.7	7.0	7.0	7.3	7.3	7.3	9.0	9.0	8.7	9.0	8.7	8.7
26	S-F-C 100 (X-419-100)	2	5.3	6.7	6.7	7.3	7.3	7.0	8.3	8.7	8.0	9.0	8.7	8.0
27	S-F-C 100 (X-419-100)	4	5.0	6.7	6.7	7.0	7.0	6.5	8.3	8.7	7.3	9.0	8.3	7.3
28	S-F-C 100 (X-419-100)	8	5.0	6.7	6.3	6.7	6.7	5.7	8.7	8.7	5.7	8.7	8.0	6.0
29	Check		7.0	7.0	7.0	7.0	7.3	7.3	9.0	8.7	9.0	9.0	9.0	9.0

[1]Rating Scale - 9 = No drainage to 1 = Complete kill.

ment period. One gpa of the oils applied 3 times at weekly intervals, in August 1964, produced no significant phytotoxic effect to 'Argentine' bahiagrass. Increasing the oil rates above 1 gpa and applying these rates 2 or 3 times at weekly intervals resulted in a highly significant increase in phytotoxicity ratings to 'Argentine' bahiagrass, (Table 8).

Table 8. AVERAGE EFFECTS OF TREATMENT DATES AND ALL RATES OF OILS ON APPEARANCE RATINGS[1] OF ARGENTINE BAHIAGRASS

Initial Rate X	Rates Total Oil Added By Repeat Treatments After 7 Days 2X	After 14 Days 3X	Treatment Dates Nov-Dec 1964	Aug 1965
gpa	gpa	gpa	Avg. X+2X+3X	
1	2	3	6.6	8.8
2	4	6	6.5	8.6
4	8	12	6.2	8.1
8	16	24	5.8	7.4
Checks			7.1	9.0
LSD:	0.05	0.01		
Between Dates	NS	NS		
Between Rates	.21	.35		

[1]Rating scale - 9 = No damage to 1 = Complete kill

Oils—All oils produced significant phytotoxic effects on 'Argentine' bahiagrass with SS TS being most toxic, (Table 9). Increased toxicity of SS TS was significant when compared to checks or any other oil. SS 91 and SS 38 were the next most toxic oils. There were no significant differences between SSP 7, SSP 11, SSP 16 and SFC 100, (Table 9).

Repeat Application of Oils—Importance of time of rating relative to date of the last oil treatment is most important because most toxicity occurred immediately following treatment, especially after the second and third applications of oils, (Table 10). Phytotoxicity to 'Argentine' bahiagrass did not increase signifi-

Table 9. AVERAGE EFFECTS OF OILS AT ALL RATES ON APPEARANCE RATINGS[1] OF ARGENTINE BAHIAGRASS, AUGUST 1965

Oil	Appearance Ratings
SS TS	7.6
SS 38	8.0
SS 91	7.9
SSP 7	8.5
SSP 11	8.5
SSP 17	8.6
SFC 100	8.6
Checks	9.0
LSD: .05	.01
Between oils .3	.5

[1]Rating scale - 9 = No toxicity to 1 = Complete kill

Table 10. AVERAGE EFFECTS OF REPEAT APPLICATIONS OF OILS ON APPEARANCE RATINGS[1] OF ARGENTINE BAHIAGRASS, AUGUST 1965

Rates	Repeat Applications Means						
All	Rating Dates						
Rates	Check	8-2	8-10		8-18		
of		1X	1X	2X	1X	2X	3X
Oils	9.0	8.8	8.7	7.4	9.0	8.3	7.0
LSD:			.05	.01			
Between repeat application means			.5	.9			

[1]Rating scale - 9 = No toxicity to 1 = Complete kill

cantly when initial treatments of all oils (X) at all rates and dates were combined. Phytotoxic effects on 'Argentine' bahiagrass were increased when treatments were re-applied after 7 days (2X) and rated 2 or 3 days later. This increased toxicity was highly significant. A third repeat application produced an additional highly significant increase in toxicity. These data show that repeated applications of oils, at weekly intervals, produced increased phytotoxic effects on 'Argentine' bahiagrass.

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INCREASING THE EFFECTIVENESS OF TURF HERBICIDES BY USE OF OIL

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ABSTRACT

A split-split plot experiment was used to determine the effects of 6 herbicides at various rates with and without oil on phytotoxicity of established sod, young sprigs and seedlings and preemergence and postemergence weed control.

Tolerance of grasses to the herbicide or herbicide-oil combination varied with the herbicide and rate used. Addition of 2 gpa of sunspray 11EL oil to the herbicides used in this experiment resulted in significantly better or equal weed control when herbicide rates were equal (in case of Banvel D) or reduced one-half (the only exception was Amchem 63-303).

Results of this experiment indicate that excellent weed control can be accomplished by adding 2 gpa of oil to one-half the presently recommended rates of prometryne, atrazine, DSMA or MSMA. Oil mixed with the recommended herbicides at one-half the recommended rate did not increase the toxicity to established sod of any of the grasses tested. The oil-herbicide combination should not be used on seedlings or young plantings.

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INTRODUCTION

Extensive research on chemical herbicides for controlling weeds in warm season turfgrasses has been conducted during the past 5 years