EFFECT OF HERBICIDES ON CRABGRASS (*DIGITARIA SANGUINALIS* (L.) SCOP.) AND VARIOUS TURF GRASS SPECIES

By

FRANK MILTON WOOLDRIDGE

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Thesis Approved:

Wayne W. Huffine
Thesis Adviser

W. C. Elder

Dean of Graduate School

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INTRODUCTION

It was reported in 1951 by the Agriculture Research Service and the United States Golf Association, Green Section, that there were eleven million acres of land in the United States that was classified as managed turf. The estimated investment and replacement value of these eleven million acres amounted to 2½ billion dollars. This value added to the value of increased acres since 1951 make the total investment for turf in the United States several billion dollars (30) / 1.

With the increasing number of acres of managed turf come the increasing problems of weed control, of which crabgrass seems to be one of the more important.

In 1951, the United States Golf Association initiated a national coordinated study in an attempt to stop conflicting reports concerning chemical control of crabgrass (24). These studies were to be conducted with the most promising turf herbicides, phenyl mercuric compounds, potassium cyanate, and sodium arsenite (11). The tests were to be conducted in three series with two or three applications for each; the first was a spring treatment, the second an early summer treatment, and the third a late summer treatment, the latter being the period for this study.

The primary objectives of this study were to determine the most

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/ 1 Figures in parentheses refer to "Literature Cited".

satisfactory herbicide and rate of applications for the control of late summer crabgrass with the least amount of injury to the permanent turf under Oklahoma conditions.

II

LITERATURE REVIEW

Early Spring Treatments for Crabgrass Control

In 1950, Lantz (14) reported that PMA (phenyl mercuric acetate) gave excellent crabgrass control in the Middle West when applied in the early spring. His results indicated PMA gave good results on a football field in Iowa when applied early and repeatedly during a growing season with continued applications through the second year.

Beatty and Davis (1) in Pennsylvania found crabgrass control and turf discoloration varied with the rates of potassium cyanate applied. They reported 3 or 4 applications of 8 pounds per acre were better than a single application of 16 pounds. In this study, they used 3 rates of potassium cyanate and found that 4 pounds gave poor crabgrass control, while an 8 pound rate gave satisfactory control with little discoloration to the turf. Sixteen pounds controlled the crabgrass satisfactorily but discolored the turf severely.

After four years of study of weed and crabgrass seedlings in bermuda grass lawns at the Georgia Coastal Plains Experiment Station, Robinson (25) reported mercuric, potassium cyanate, and sodium arsenite compounds varied in their control of crabgrass with sodium arsenite being the least effective. These results indicated the herbicidal effect of several formulations of mercuric compounds were significantly different. His results further indicated the control of crabgrass and weeds varied with

the formulation of potassium cyanate used. Of the sodium arsenite compounds used, he found that their effectiveness was improved with the addition of a wetting agent.

Early Summer Treatment for Crabgrass Control

From studies conducted in the early summer of 1950, DeFrance and Simmons (3) reported PMAS (phenyl mercuric acetate) was very effective for crabgrass control in Colonial bentgrass. In this study early applications at 10- and 20-day intervals, with 1.3 and 1.6 ounces of PMAS in 10 gallons of water per 1000 square feet, gave 100 percent and 95 percent crabgrass control, respectively.

A study conducted in 1954 by DeFrance and Hart (5) indicated turf discoloration following herbicide application was more severe when the turf was in a weakened condition as the result of extremely hot and dry weather. They reported discoloration varied with the herbicide used. PMAS discolored the turf somewhat more than potassium cyanate, regardless of the weather conditions.

From work conducted in Minnesota, Nyland (20) reported PMA and potassium cyanate varied in the control of crabgrass when applied at rates that did not cause injury to a bluegrass turf. His results indicated that when applied at the manufacturer's recommended rate, PMA and potassium cyanate gave 100 percent and 80 percent control of crabgrass, respectively. In later studies, Nyland (21) obtained somewhat different results by applying 5 pints of 10 percent PMA, 8 pounds of potassium cyanate, and 1 pound of sodium arsenite in 100 gallons of water per acre to a bluegrass turf. He found PMA, potassium cyanate, and sodium arsenite gave 85, 75, and 52 percent crabgrass control, respectively, with potassium cyanate and sodium arsenite producing somewhat more discoloration than PMA.

In 1955, Nyland and Stadthen (22) found PMAS and potassium cyanate varied in crabgrass control and discoloration of a bluegrass turf. The results of this study indicated 8 pounds of potassium cyanate per acre gave 75 percent control of the crabgrass without excessive turf discoloration, whereas 4½ pints of 2.5 percent PMAS per acre gave 100 percent crabgrass control, but caused severe discoloration of the turf grass.

Nutter and Cornman (18) in New York reported the weather conditions at the time of application were more important than the stage of growth of the crabgrass plants. This study further indicated that potassium cyanate was not as effective in droughty periods as when conditions were favorable for good growth. Under favorable conditions 8 and 16 pounds of potassium cyanate per acre gave 85 percent control of the crabgrass when at least 2 applications were made. Further studies by Nutter and Cornman (19) revealed that PMA and potassium cyanate effects varied as to the time of applications and as to the speed of reaction. PMA was most effective after mid-summer but slow in its reaction, while potassium cyanate was most effective after mid-August and showed its effect readily.

At East Linsing, Michigan, Grigsby (13) found PMA produced best results when applied as a liquid rather than a dry powder mixed in sand. His results indicated an overdosage of PMA tended to cause more turf injury than the other materials used. When PMA was used at twice the rate recommended by the manufacturer, the turf was severely damaged. In addition, he found that potassium cyanate at the rates of 8 and 12 pounds per acre gave less than 50 percent control of the crabgrass with some injury to the lawn grass. An application of 16 pounds per acre killed the top growth of the crabgrass but failed to stop regrowth and caused more injury to the turf than the lighter rates.

In 1951, Lantz (15) in Iowa reported that when PMA, potassium cyanate, and sodium arsenite were applied at four dates, starting in early July, the effect varied with the date of application and material. The potassium cyanate caused severe burning but apparently no permanent injury to the turf. Early and midseason applications of potassium cyanate gave about 89 percent crabgrass control, while the late season application gave 95 percent control when the crabgrass was in the early boot stage. He noted the first visible effect of the PMA treatment was a yellow coloration of the crabgrass. The early application of PMA gave 95 percent control of the crabgrass, while midseason applications gave 90 to 92 percent control, and those made in the latter part of summer resulted in 87 to 90 percent control. Regardless of the time of application, sodium arsenite did not give satisfactory crabgrass control. In 1954, Lantz (17) found three early applications of PMA and a single application of potassium cyanate powder at the time of seed head formation was effective in the control of crabgrass.

In Nebraska, Finnerty (10) found the best crabgrass control was obtained when applications were made in the early summer. Ten pints of PMA per acre applied in the early summer controlled 86 percent of the crabgrass with only 10 percent injury to a bluegrass turf, while 5 pints of PMA gave only 65 percent control and 5 percent injury to the bluegrass. His results indicated in a late summer application of 8 pounds of potassium cyanate per acre only 65 percent of the crabgrass was controlled with 6 percent injury to the bluegrass. Two pounds of sodium arsenite per acre controlled 63 percent of the crabgrass with 5 percent bluegrass injury. However, he noted that potassium cyanate and sodium arsenite varied in their ability to control crabgrass at most rates and dates.

The results of Waywell and Bibbey's (29) work in Ontario, Canada indicated PMAS and potassium cyanate gave good crabgrass control. The PMAS at three ounces in three gallons of water per square rod gave good control of the crabgrass if more than one application was made. Effective rates of the PMAS caused the Kentucky bluegrass to become yellow for a short time. They found 2 applications of 2 gallons of 0.2 percent potassium cyanate per square rod gave good crabgrass control with only minor injury to the Kentucky bluegrass.

Peek, Noah, and Hinkle (23) in Arkansas reported PMAS gave best control of crabgrass after the crabgrass had passed the seedling stage of growth.

The results of studies conducted in Ohio by Davis and Willard (2) indicated PMAS, potassium cyanate, and sodium arsenite gave good crabgrass control in bluegrass lawns. They found that PMAS gave excellent crabgrass control when the grass was in the 2-3 leaf stage. Potassium cyanate and sodium arsenite gave good results when used on both seedling and mature crabgrass.

In studies carried on in Texas in cooperation with the National Crabgrass Trials, Watson (28) found PMAS, potassium cyanate, and sodium arsenite were most effective when the crabgrass was in the 2-3 leaf stage. He reported the herbicidal efficiency varied with the stage of crabgrass growth. Of the herbicides used, sodium arsenite was most effective on mature crabgrass. Potassium cyanate was not quite as effective but appeared satisfactory. PMAS was somewhat more effective against seedling crabgrass than the mature plants.

Lantz (16) found a single application of potassium cyanate gave somewhat better crabgrass control than PMAS. The potassium cyanate, he

noted, was most effective when applied as the crabgrass approached seed head formation. He found it gave 100 percent control of the seedling crabgrass, but within one month's time new seedlings appeared. The PMAS was effective on the seedling crabgrass only, and at this stage of growth gave approximately 90 percent control.

Late Summer Treatments for Crabgrass Control

Gallagher and Emmerson (12) in Pennsylvania observed that potassium cyanate gave satisfactory control of mature crabgrass in a mixed turf of Kentucky bluegrass and Creeping bentgrass.

In Illinois, Slife (26) reported, after three years of study, potassium cyanate gave excellent crabgrass control while PMAS was variable in its effect on the grass. He found potassium cyanate caused more severe injury to the turf when the temperatures were excessively high.

From the results of studies conducted in Rhode Island in 1952, DeFrance and Simmons (4) reported PMA and potassium cyanate varied in their effect on a turf combination of Chewings fescue, Kentucky bluegrass, and Colonial bentgrass. The PMA gave excellent crabgrass control without objectionable discoloration of the turf. Potassium cyanate resulted in only fair to good crabgrass control and caused considerable discoloration.

DeFrance and Hart (6) concluded from a study conducted in 1953, in which seven materials were used, that PMAS and potassium cyanate were not significantly different in mature crabgrass control; however, potassium cyanate produced somewhat more turf discoloration than PMAS.

The results of work done in New Jersey in 1949 by Engel and Wolf (8) indicated phenyl mercury compounds were erratic and less effective than potassium cyanate in the control of crabgrass. When they applied

phenyl mercury compounds to a Kentucky bluegrass turf, they found a marked similarity in crabgrass control with the various materials used, with higher concentrations being required during the dry weather of early August. Their results indicated potassium cyanate gave better control of crabgrass in this period but caused more turf injury.

In 1952, Engel, Aldrich, and Ahlgren (9) reported, after 4 years of study in New Jersey, potassium cyanate and PMA treatments resulted in an average crabgrass control of 89 percent while sodium arsenite averaged approximately 20 percent less. The injury produced on a Kentucky bluegrass turf by these herbicides increased in the order of PMA, potassium cyanate, and sodium arsenite. In addition, they found crabgrass control was less favorable when the climatic conditions were not hot and dry.

III

MATERIALS AND METHODS

This study was conducted on a Kirkland silt loam soil at the Oklahoma Agricultural Experiment Station Agronomy Farm located near Stillwater, Oklahoma.

The crabgrass plots were established on land that had not been cultivated for several years. The soil was disked and harrowed, then irrigated with two Rainbird sprinklers (model 30 WTH, nozzle size 5/32 inch) at approximately seven-day intervals at the rate of two to three inches of water per application for six weeks. This practice was employed in an attempt to produce and maintain a uniform stand of crabgrass for this study.

A randomized block design with four replications was used. Individual plots were $8\frac{1}{2}$ feet wide and $16\frac{1}{2}$ feet long or 136.13 square feet in size. The three herbicides used were PMAS (10% active phenyl mercuric acetate), potassium cyanate (89% active potassium cyanate), and sodium arsenite (32.5% active arsenic trioxide). The PMAS was applied at the rates of 5, $7\frac{1}{2}$, 10, and 15 pints per acre. The rate of application of potassium cyanate was 8, 12, 16, and 24 pounds per acre and sodium arsenite was applied at the rates of 1, $1\frac{1}{2}$, 2, and 3 pounds per acre. The first three rates of each herbicide were applied in three applications at approximately seven-day intervals starting August 3 when the crabgrass was in the boot stage. The fourth rate of each herbicide was applied as a single application August 18 at the time of the third and final application of the lighter treatments.

The materials, rates, and methods mentioned above were applied to an established U-3 Bermuda grass plot to study the effects of the herbicides and their rates on an established turf.

To study the effect of these herbicides on various turf grasses, a single rate of each was applied to 18 species or selections. PMAS, sodium arsenite, and potassium cyanate were applied at the rate of 7½ pints, 1½ and 12 pounds per acre respectively, to well established plots of the following turf grass species or selections:

Zoysia matrella

Eremochloa ophiuroides (Centipede grass)

Cynodon magennesii P. I. 184338 (Sunturf Bermuda)

Cynodon transvaalensis (African Bermuda)

Zoysia matrella var. japonica (Meyer Z-52)

Cynodon dactylon (Tiflawn T-57)

Cynodon dactylon x Cynodon transvaalensis (Tiffine T-127)

Agrostis palustris (Seaside Bent)

Poa pratensis (Delta Bluegrass)

Poa pratensis (Merion Bluegrass)

Buchloe dactyloides (Buffalo No. 15 Sel.)

Buchloe dactyloides (Commercial Buffalo)

Buchloe dactyloides (Buffalo No. 9 Sel.)

Zoysia matrella var. japonica (Z-73)

Cynodon dactylon (T-35-A Bermuda)

Festuca arundinacea (Kentucky 31 fescue)

Lolium perenne (Perennial Ryegrass)

Zoysia matrella var. japonica (Japanese lawngrass)

These species or selections received three applications of the herbicides at approximately seven-day intervals starting August 4.

To determine the effectiveness of urea compounds as a possible control of mature crabgrass in late summer and its effect on established turf, Karmex (30% active 3-(3, 4 dichlorophenyl) - 1, 1 dimethylurea) was applied at the rates of 1 and 2 pounds per acre to crabgrass, U-3 Bermuda, Kentucky 31 fescue and common bermuda grass mixture, and a combination of New Zealand ryegrass and U-3 Bermuda as a single treatment on August 19.

Knapsack sprayers equipped with two Tee Jet-6503 nozzles on a one-foot boom were used to apply the herbicides. Each herbicide was applied in 100 gallons of water per acre at a pressure of 40 pounds per square inch. Separate sprayers were used for each of the herbicides to eliminate any chance for error due to contamination.

To facilitate the development of proper air pressure, each sprayer was equipped with a valve stem for use with a small air compressor powered by a gasoline motor.

A frame, made of 1" x 12" lumber standing on edge, was placed around the plots as they were sprayed to eliminate as much as possible the drift of the herbicide to adjoining plots.

Evaluation of each herbicide and rate of application for crabgrass control was based on actual plant counts and degree of injury in four (1 foot square) randomly placed quadrats in each plot. The degree of injury was derived by the use of 6 stages of vegetative damage, 100% (total kill), 99-75%, 75-50%, 50-25%, 25-1%, and 0% (no damage).

The turf injury was determined by visual observation of the treated area and was rated as 1 - no effect, 2 - slight discoloration, 3 - moderate discoloration, 4 - severe discoloration, and 5 - very severe discoloration.

The analysis of variance was obtained on the mean percent of crabgrass damage. This was done by the method outlined by Snedecor (27).

The multiple range test was computed for the mean percent of crabgrass damage as proposed by Duncan (7).

IV

RESULTS AND DISCUSSION

Effect of Various Herbicides on Crabgrass

In this study herbicidal effect was somewhat different from the expected in that none of the herbicides at the rates applied gave satisfactory control (90 to 100 percent) of the crabgrass.

The PMAS that was applied in 3 applications at the rates of 5, 7½, and 10 pints per acre gave 58.3, 59.1, and 74.5 percent crabgrass damage, respectively. The 3 applications of potassium cyanate at the rates of 8, 12, and 16 pounds per acre produced 43.8, 53.9, and 62.2 percent injury of the crabgrass, in that order. The 1, 1½, and 2 pound rates of sodium arsenite per acre, each being applied in 3 applications, resulted in 30.8, 36.2, and 40.1 percent crabgrass damage, respectively.

Single applications of 15 pints of PMAS, 3 pounds of sodium arsenite, and 24 pounds of potassium cyanate per acre gave 34.6, 34.5, and 47.2 percent crabgrass injury, respectively.

A significant difference (5% probability level) in the percent of crabgrass injury was noted between the various treatments and rates, Table I. With the one exception of 16 pounds of potassium cyanate, 10 pints of PMAS gave significantly better crabgrass control than the other treatments and rates. Sixteen pounds of potassium cyanate resulted in significantly greater crabgrass control than the 8 pound rate of this material or the 1, 1½, 2, and 3 pound rates of sodium arsenite; and the 15 pints rate of PMAS. Of the rates of PMAS used, the 5 and 7½ pint

TABLE I

ANALYSIS OF VARIANCE OF THE MEAN PERCENT OF DAMAGE OF CRABGRASS PLANTS SUBJECTED TO A SINGLE AND THREE REPEATED APPLICATIONS OF PMAS, POTASSIUM CYANATE, AND SODIUM ARSENITE.

Source	d.f.	S.S.	M.S.	F.
Total	47	11,966.32		
Treatment	11	8,218.25	747.11	7.87**
Reps.	3	616.13	205.38	
Error	33	3,131.94	94.91	

S. E. M. = 4.87 C. V. = 20.3%

MULTIPLE RANGE TEST OF RANKED MEAN PERCENT OF CRABGRASS DAMAGE.

1 lb. Na As	3 lbs.* Na As	15 pts.* PMAS	1 1/2 lbs. Na As	2 lbs. Na As	8 lbs. KOCN	24 lbs.* KOCN	12 lbs. KOCN	5 pts. PMAS	7 1/2 pts. PMAS	16 lbs. KOCN	10 pts. PMAS
means											
30.8	34.5	34.6	36.2	40.1	43.8	47.2	53.9	58.3	59.1	62.2	74.5[1]

* Means of single applications. All others are means of three applications.
** Significant at the 1% probability level.
1. All means not underscored by the same line are significantly different at the 5% probability level.

rates were not significantly different in control of crabgrass; however, they were significantly better than the 15 pint rate, and the 1, 1½, 2, and 3 pound rates of sodium arsenite. The 12 pound rate of potassium cyanate was significantly greater than the 1, 1½, and 3 pound rates of sodium arsenite, and the 15 pint rate of PMAS. The 24 pound rate of potassium cyanate was significantly higher in percent injury than the 1 pound rate of sodium arsenite.

Effect of Various Herbicides on Other Weeds

Since other weeds were present in the crabgrass area, an attempt was made to study the herbicide effect on these weeds at the rates used in the crabgrass study, Table II. However, only Flower-of-an-hour (Hibiscus Trionum L.), and Carpetweed (Mollugo verticillata L.) were present in all of the replicated plots, so it was not possible to observe the effects of all rates on all of the weeds identified.

Potassium cyanate produced 97.8 and 100 percent control of Flower-of-an-hour and pigweed (Amaranthus graecizans L.), respectively. PMAS applied on Smooth Ground Cherry (Physalis subglabrata Mackenz & Bush.), and Nutgrass (Cyperus esculentus L.) caused 33 and 62 percent injury respectively, and 100 percent control of Milky Purslane (Euphorbia supina Raf.) Prickley Sida (Sida spinosa L.), and Portulaca parvula Gray. Sixty-two and one-half percent of the Horse Nettle (Solanum elaeagnifolium Cav.) was damage with sodium arsenite. A single application of each of the 3 herbicides gave 99 to 100 percent control of Carpetweed.

TABLE II

MEAN PERCENT DAMAGE OF OTHER WEEDS PRESENT IN THE CRABGRASS PLOTS SUBJECTED TO A SINGLE AND THREE REPEATED APPLICATIONS PMAS, POTASSIUM CYANATE, AND SODIUM ARSENITE.

	Flower-of-an-hour	Carpetweed	Horse Nettle	Nutgrass	Milky Purslane	Prickly Sida	Smooth Ground Cherry	Portulaca parvula	Pigweed
Three Applications									
5 pts. PMAS	39.0	99.9	25.0	62.0	75.0	99.0	33.3		
7 1/2 pts. PMAS	66.5	100.0	50.0		100.0	100.0		100.0	
10 pts. PMAS	63.1	100.0		30.0	100.0			99.7	25.0
8 lbs. KOCN	67.7	100.0	50.0		25.0			46.9	100.0
12 lbs. KOCN	84.4	100.0	50.0	37.5	37.5			59.2	100.0
16 lbs. KOCN	97.8	100.0	56.2		25.0				
1 lb. Na As	58.3	89.8				37.5	25.0	12.5	81.2
1 1/2 lbs. Na As	30.5	88.0	62.5	12.5	31.2			43.8	
2 lbs. Na As	50.0	99.0	50.0		25.0	00.0		25.0	
Single Application									
15 pts. PMAS	25.0	100.0	37.5	25.0	31.2	26.2	32.1	25.0	87.5
24 lbs. KOCN	61.6	99.9			33.3	75.0		50.0	
3 lbs. Na As	25.0	99.0	25.0	25.0	25.0	73.1		50.0	62.5

U-3 Bermuda

Results of the herbicide applications on the established U-3 Bermuda turf indicated herbicidal effect varied with the herbicide and rate, Table III. The rates of potassium cyanate used gave a quick discoloration that rapidly disappeared. The PMAS caused a slower yellowish discoloration that existed longer than that caused by the other two materials. Sodium arsenite discolored the turf about the same as PMAS, but it dissipated sooner than that caused by PMAS and potassium cyanate.

The potassium cyanate caused severe to very severe discoloration of the U-3 Bermuda from the first through the third and final application. However, two weeks after the final application the discoloration was slight.

Sodium arsenite treatments caused slight to moderate discoloration from the first through the third and final application, but two weeks following the third application there was no visual effect.

The PMAS treatments produced slight discoloration through the second application, but after the third and final application it resulted in moderate to severe discoloration. Two weeks following the third application the discoloration was slight.

In 1955 there was no apparent residual effect of the herbicides applied in 1954 on the U-3 Bermuda.

TABLE III

MEAN DISCOLORATION CAUSED BY THE TREATMENTS OF PMAS, POTASSIUM CYANATE, AND SODIUM ARSENITE ON AN ESTABLISHED U-3 BERMUDA TURF.

	1954				1955
	Aug. 6	Aug. 13	Aug. 21	Sept. 1	June 10
Three Applications					
5 pts. PMAS	1.75 [1]	2.00	2.75	2.00	1.00
7 1/2 pts. PMAS	2.00	2.25	3.00	2.00	1.00
10 pts. PMAS	2.00	2.25	3.50	2.00	1.00
8 lbs. KOCN	2.75	3.00	3.50	1.25	1.00
12 lbs. KOCN	4.25	4.25	4.25	1.00	1.00
16 lbs. KOCN	4.50	5.00	4.75	1.00	1.00
1 lb. Na As	2.00	2.50	2.00	1.00	1.00
1 1/2 lbs. Na As	2.50	3.25	2.25	1.00	1.00
2 lbs. Na As	1.75	3.00	2.25	1.00	1.00
Single Application					
15 pts. PMAS			3.00	1.75	1.00
24 lbs. KOCN			5.00	1.00	1.00
3 lbs. Na As			2.75	1.00	1.00

1 Figures represent the amount of discoloration caused by treatments at the various dates of application, 1 - no effect, 2 - slight discoloration, 3 - moderate discoloration, 4 - severe discoloration, 5 - very severe discoloration.

Species or Selections

The results of 18 species or selections of turf grasses receiving PMAS, potassium cyanate, and sodium arsenite applications indicated that the species and selections varied in respect to herbicidal tolerence, Table IV.

The most severe discoloration caused by each of the herbicides occurred after the second application on August 13, 1954. The severe discoloration at that time was possibly due to the weakened condition and reduced leaf area of the grasses because of mowing the day before the application.

Applications of PMAS had the longest residual effect of the materials used with only Seaside bent, Delta and Merion bluegrass being discolored severely. Of the three materials used, potassium cyanate caused the most severe discoloration on all of the turf grasses; however, with the exception of Seaside bent, all varieties quickly recovered. For the most part, sodium arsenite did not react with the turf grasses as harshly as potassium cyanate, but somewhat more severely than PMAS. However, nine of the varieties, Sunturf Bermuda, Meyer Z-52 Zoysia, Seaside bent, Delta and Merion bluegrass, commerical Buffalo, Buffalo No. 15, Zoysia japonica Z-73, and perennial ryegrass were severely discolored after the second application.

With the exception of Seaside bent treated with potassium cyanate, all the species and selections of turf grasses receiving potassium cyanate and sodium arsenite showed no residual effect two weeks after the third and final application. Of the grasses receiving PMAS treatments, only Centipede grass had fully recovered two weeks after the final

TABLE IV

OBSERVATIONS OF THE DISCOLORATION CAUSED BY PMAS, POTASSIUM CYANATE, AND SODIUM ARSENITE ON EIGHTEEN TURF GRASSES, 1954.

Variety	7 1/2 pts. PMAS per acre				12 lbs. KOCN per acre				1 1/2 lbs. Na As per acre			
	8/6	8/13	8/21	9/1	8/6	8/13	8/21	9/1	8/6	8/13	8/21	9/1
Zoysia matrella	2[1]	3	2	2	3	3	2	1	2	2	2	1
Centipede grass	2	2	2	1	3	5	3	1	1	2	2	1
Sunturf bermuda	2	2	2	2	2	4	2	1	2	4	2	1
African bermuda	2	2	2	3	2	2	2	1	1	2	2	1
Meyer Z-52 Zoysia	2	2	2	2	2	5	2	1	1	4	2	1
Tiflawn T-57	2	2	2	2	2	2	2	1	1	2	2	1
Tiffine T-127	3	2	2	2	3	3	2	1	2	3	2	1
Seaside bent	2	4	3	5	2	5	3	4	2	5	2	1
Delta bluegrass	2	4	3	2	2	5	2	1	2	4	2	1
Merion bluegrass	2	4	3	4	2	5	2	1	2	4	2	1
Buffalo No. 15	2	2	2	2	3	5	4	1	1	5	3	1
Commercial buffalo	2	2	2	2	3	5	4	1	1	4	3	1
Buffalo No. 9	2	2	2	2	3	5	4	1	2	3	2	1
Zoysia japonica Z-73	2	3	2	2	2	5	2	1	2	4	2	1
T-35-A bermuda	1	2	2	2	2	3	2	1	1	2	2	1
Kentucky 31 fescue	2	2	2	2	2	3	2	1	2	2	2	1
Perennial ryegrass	2	2	2	2	2	3	2	1	2	4	3	1
Zoysia japonica	2	2	2	2	2	3	2	1	2	2	2	1

1 Figures represent the amount of discoloration caused by the treatments 2 or 3 days following the application, 1 - no effect, 2 - slight discoloration, 3 - moderate discoloration, 4 - severe discoloration, and 5 - very severe discoloration.

application with Seaside bent and Merion bluegrass still showing severe discoloration.

In 1955, there was no apparent residual effect in any of the species or selections treated in 1954.

Herbicidal Effect of Urea on Crabgrass and U-3 Bermuda

A late summer treatment of a single application of Karmex did not give satisfactory crabgrass control when applied to plots of crabgrass alone. However, it was noted that when the Karmex was applied to a U-3 Bermuda turf in which crabgrass was present, a 2 pound rate per acre gave 83.0 percent reduction in the number of crabgrass plants.

In the crabgrass area, 1 pound of Karmex per acre gave 50.4 percent crabgrass damage while the 2 pound rate gave only 40.8 percent damage, Table V. This higher percent of damage to the crabgrass by the lighter application rate was probably because one replication receiving this treatment fell on the fringe of the irrigated area and a number of the crabgrass plants were in the 2-3 leaf stage.

When a single treatment of 1 pound of Karmex per acre was applied to the U-3 Bermuda, the crabgrass population was reduced from 385.5 plants before application to 241 two weeks after application or 37.4 percent control of the crabgrass. At the same time the 2 pound rate of Karmex reduced the crabgrass population from 303.0 plants before application to 53.0 plants two weeks after application or 82.5 percent crabgrass control, Table V.

The discoloration of the U-3 by Karmex, being rated in the same manner as that of PMAS, potassium cyanate, and sodium arsenite, was no more severe than that caused by a single application of potassium cyanate,

TABLE V

MEAN PERCENT OF CRABGRASS DAMAGE IN CRABGRASS ALONE AND THE MEAN PERCENT OF CRABGRASS DAMAGE AND TURF DISCOLORATION IN U-3 BERMUDA BY KARMEX

Treatment of Crabgrass		Treatment of U-3 Bermuda						
		Number of Plants						
Rate per Acre	Percent Damage	Before Treatment	After Treatment	Killed	Percent Control	Discoloration 9/1/54	9/6/54	6/10/55
1 pound Karmex	50.4	385.5	241.0	144.5	37.4	2.0[1]	1.0	1.0
2 pounds Karmex	40.8	303.0	53.0	250.0	83.0	4.0	3.5	1.0

1 Figures represent the amount of discoloration caused by the Karmex treatments; 1 - no effect, 2 - slight discoloration, 3 - moderate discoloration, 4 - severe discoloration, and 5 - very severe discoloration.

Table V. However, Karmex showed the longest residual effect of all the materials used. The one pound rate caused the U-3 to be slightly discolored two weeks after its application which was somewhat more than the single applications of the other three herbicides at that time. At the same time the two pound rate of Karmex caused the U-3 to be severely discolored as compared to very slight discoloration of the other herbicides. Three weeks after the Karmex application there was no effect from the one pound rate, while the two pound rate was causing moderate to severe discoloration.

There was no apparent discoloration or injury on the U-3 Bermuda in 1955, as a result of the 1954 Karmex treatments.

It was noted that there seemed to be species differences in the tolerance of Karmex. When Karmex was applied to a combination of Kentucky 31 fescue and Common Bermuda, and a combination of New Zealand ryegrass and U-3 Bermuda at 2 pounds per acre, 90 percent of the Kentucky 31 was killed while the 1 pound rate killed 10 and 75 percent of the New Zealand ryegrass and Kentucky 31, respectively.

V

SUMMARY

Four herbicides, PMAS, potassium cyanate, sodium arsenite, and Karmex, were used in this study for the control of mature crabgrass and to determine their effect on various turf grasses. The PMAS, potassium cyanate, and sodium arsenite were applied at three rates in three applications and at a single rate applied in one application. The Karmex was applied at two rates in a single application.

None of these herbicides at the rates used gave satisfactory control of the crabgrass in the late summer.

The herbicidal tolerance varied as to the species of weeds that were present in the crabgrass plots. PMAS was most effective in the control of Smooth Ground Cherry (Physalis subglabrata Mackenz & Bush.), Nutgrass (Cyperus esculentus L.), Milky Purslane (Euphorbia supina Raf.), Prickley Sida (Sida spinosa L.), and Portulaca parvula Gray. Potassium cyanate gave best results in the control of Flower-of-an-hour (Hibiscus Trionum L.) and Pigweed (Amaranthus graecizans L.), while sodium arsenite was the most effective in the control of Horse Nettle (Solanum elaeagnifolium Cav.). A single application of each of the herbicides gave very good control of Carpetweed (Mollugo verticillata L.).

Each herbicide reacted somewhat differently on an established U-3 Bermuda grass turf. Potassium cyanate caused discoloration sooner and more severely than the other materials. PMAS was slower in its effect and less severe than potassium cyanate. Sodium arsenite discolored the

U-3 sooner than PMAS, but not as rapidly as potassium cyanate. Its severity was equal to that of PMAS and considerably less than that of potassium cyanate. Karmex showed the longest residual effect of all the herbicides used. However, it was not as severe as potassium cyanate, but more severe than sodium arsenite and PMAS.

Eighteen species or selections of turf grasses subjected to treatments of PMAS, potassium cyanate, and sodium arsenite indicated that the herbicidal effect varied with the species or selections. Two weeks after the third and final applications of PMAS, Centipede grass was the only variety showing no effect, while African Bermuda, Merion bluegrass, and Seaside bent had moderate to severe discoloration; all of the others were slightly discolored. At the same time potassium cyanate was causing severe discoloration to Seaside bent only, whereas sodium arsenite was showing no effect on any of the species of selections.

PMAS, potassium cyanate, and sodium arsenite, at the rates used, caused no permanent injury to any of the species and selections treated; however, Karmex did cause permanent injury to Kentucky 31 fescue and New Zealand ryegrass.

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VITA

Frank Milton Wooldridge

Candidate for the Degree of

Master of Science

Thesis: EFFECT OF HERBICIDES OF CRABGRASS (DIGITARIA SANGUINALIS (L.) SCOP.) AND VARIOUS TURF GRASS SPECIES

Major Field: Agronomy (Field Crops)

Biographical:

Personal data: Born at Martha, Jackson County, Oklahoma, February 9, 1929, the son of Hudson and Nell Wooldridge.

Education: Attended elementary and high school at Martha, Oklahoma; graduating in May, 1948; received the Bachelor of Science degree from Oklahoma State University, with a major in Agronomy (Field Crops), January, 1954; completed requirements for the Master of Science degree, May, 1958.

Professional experience: Born and reared on a farm; Military Service, United States Air Force, Supply Squardron, March 10, 1951, to August 29, 1952; Instructor in Agronomy, Oklahoma State University, February 1, 1955, to present.