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To the Graduate Council:

I am submitting to you a thesis written by Sam F. McMurray entitled "Chemical Weed Control Experiments with Cotton". I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

E. Winters
Major Professor

We have read this thesis
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CHEMICAL WEED CONTROL EXPERIMENTS WITH COTTON

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

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by

Sam F. McMurray

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CHAPTER I

INTRODUCTION

It is generally agreed that weed control is the phase of cotton production that has been least satisfactorily mechanized. Therefore, it would be highly desirable to find a chemical and a method of application that is economical and effective in controlling weeds in cotton to the extent that hand chopping will not be necessary. This is becoming more important as farm labor is being utilized by industry in war production. An excellent opportunity to search for this information was made available through the Weed Control Project of the University of Tennessee Agricultural Experiment Station. During the 1949 season four preliminary experiments were conducted, two at the U. S. Cotton Field Station at Knoxville and two at the West Tennessee Experiment Station at Jackson, using four of the more promising chemicals. The most effective chemical of the four tested was used in more detailed experiments at the same locations in 1950.

A brief report of the 1949 preliminary tests will be given as a basis for the 1950 experiments. Observational notes and yield data from the two experiments conducted in 1950 will be given in detail.

CHAPTER II

REVIEW OF LITERATURE

Prior to 1948 very little research had been conducted on chemical weed control in cotton. However, much work had been done with mechanical weed control equipment such as flame cultivators. Following is a summary of the work with chemicals.

In 1948 Leonard (16) of the Mississippi Agricultural Experiment Station reported that 6 pounds per acre of "dinitro"[1] controlled the annual weeds without injury to several crops, one of which was cotton. This screening test was observed by the members of the Southern Weed Control Conference in 1948 and since that time the experimental work with this and other chemicals for weed control in cotton has greatly expanded.

Tullis (29) in 1948 and Ergle and Dunlap (9) in 1949 working on weed control in Texas, reported on the sensitivity of cotton to 2,4-D and warned against the use of this material on or around cotton.

Cowart and Creasy (2), after conducting extensive work in cotton in 1949 and 1950, released tentative recommendations for the use of dinitro in cotton for Louisiana in 1951.

Talley (26) released tentative recommendations for Mississippi on the use of chemicals for controlling weeds in cotton with emphasis on herbicidal oils as post-emergence sprays.

Hinkle, Buchal, and Stanton (12) gave the results of work con-

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[1] See page 6 for composition.

ducted in Arkansas in a bulletin released in 1951 recommending the use of dinitro and herbicidal oils as effective weed killers in cotton.

Albert (1) made recommendations in 1951 in a South Carolina station bulletin for dinitro as a pre-emergence herbicide in cotton. He summarized the work very well in these words:

> Although the problems of weed control in cotton are far more complex than in corn, a partial control of weeds can be obtained by the chemical methods that have been presented. Imperfect as these methods are, they will doubtless become of relatively greater importance if present trends towards increased mechanization of cotton production continue. Neither have the possibilities of commercially available herbicides been fully explored in the experimentation of the past three seasons.

CHAPTER III

METHODS OF EXPERIMENTATION

The chemical weed control experiments with cotton were planned to kill weeds in the germinating stage, which would prevent them from ever growing, rather than killing them after they become established in the cotton. In order to do this, pre-emergence spraying is necessary. The term "pre-emergence" is given to the method of spraying the soil after a crop is planted and before it emerges. "Post-emergence" sprays are applied after the crop emerges.

Four experiments were conducted in 1949, two on Decatur silty clay loam at Knoxville and two on Lintonia silt loam at Jackson. A randomized block design was used in all experiments, two of them having 4 replications and two having 6 replications. Each plot consisted of two rows 50 feet long. The objective of these tests was to find out which of the 4 more promising chemicals was the best selective herbicide in cotton and to determine the duration of any toxic effect due to these chemicals. Degree of weed control was determined by periodic field observation and crop yields were taken as a measure of the effectiveness of weed control.

The 1950 experiments were set up to compare two formulations of dinitro both with and without a post-emergence oil treatment. Both experiments had randomized block designs with 4-row plots 50 feet long. The 2 center rows were harvested for yield. The Knoxville test was replicated six times and the Jackson test four times. All chemicals

were applied with a 3-gallon hand sprayer except the herbicidal oils at Jackson, which were applied with the special field equipment designed for applying these herbicides. All plots were drilled to a stand so that thinning would not be necessary. Field notes were taken on the degree of weed control, duration of toxic effects, amount of injury to the cotton, and size of bolls, in addition to the yields of cotton. Pictures were taken at different stages of the cottons' growth and are included to show the type of control obtained by the chemicals.

CHAPTER IV

RESULTS

The 1949 preliminary experiments were designed to test four chemicals as pre-emergence sprays at their most effective rate, which was determined by previous screening tests on cotton and other similar crops. Information was obtained on their effectiveness as weed killers and on their toxicity to the cotton plants which was obvious without yield data.

The chemicals and rates used in the 1949 experiments were:[1]

1. 2,4-dichlorophenoxyacetic acid (2,4-D) at 1/3 pound per acre
2. Sodium pentachlorophenate (PCP) at 30 pounds per acre
3. Isopropyl-N-phenyl carbamate (IPC) at 6 pounds per acre
4. Dinitro ortho secondary butylphenol (Dinitro) at 6 pounds per acre.

Dinitro and PCP gave very good weed control for a period of 6 weeks with no apparent injury to the cotton from the dinitro and only slight seedling injury from the PCP. The 2,4-D and IPC both reduced the stand of cotton and gave very poor weed control.

Results from the 1949 experiments and similar tests from other states, showed that dinitro was the safest and most effective herbicide on the market at this time for controlling weeds in cotton. On the basis of this information the 1950 experiments were planned to use dinitro both

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[1] The rates given are based on pounds of active ingredient and not on the pounds of commercial material.

in the water soluble and oil soluble formulations, and follow these treatments with an herbicidal oil when weeds began to appear, and again about one week later to kill the weeds that escaped the previous treatments.

Herbicides used in the 1950 experiments were:

1. Water soluble dinitro. - Alkanolamine salts of dinitro ortho secondary butylphenol sold under the commercial name of "Dow Premerge" which contains 3 pounds of active ingredient per gallon, formulated to use water as a diluent.

2. Oil soluble dinitro. - Dinitro ortho secondary butylphenol sold under the commercial name of "Dow General" which contains 5.12 pounds of active ingredient per gallon, formulated to use a light oil as a diluent.

3. Lion Herbicidal Oil No. 1. - This is a petroleum naphtha having a boiling range of 300° to 400° F. and contains 22 percent aromatic hydrocarbon by weight. It was used in the Jackson experiment.

4. Esso Weed Killer 38. - This is a naphtha petroleum product of similar composition to the Lion product. It was used in the Knoxville experiment.

Treatments in the 1950 experiments were as follows:

No. 1. Check - standard cultivation and chopping

No. 2. Pre-emergence - water soluble dinitro applied at 2 pounds per acre in a 14-inch band with the row in the center

No. 3. Pre-emergence - oil soluble dinitro applied at 2 pounds per acre in a 14-inch band with the row in the center

No. 4. Treatment number 2 plus 2 post-emergence applications of herbicidal oil at 5 gallons per acre per application in an 8-inch band with the row in the center

No. 5. Treatment number 3 plus 2 post-emergence applications of herbicidal oil at 5 gallons per acre per application in an 8-inch band with the row in the center

No. 6. Treatment 2 plus one late chopping

No. 7. Treatment 3 plus one late chopping

No. 8. Treatment 4 plus one late chopping

No. 9. Treatment 5 plus one late chopping

No. 10. Post-emergence oil only - applied at same rate and time as treatments 4 and 5

No. 11. Check - standard cultivation and no chopping

Treatments 1-5 were in both tests. Treatment 11 was in the Knoxville test only and treatments 6-10 were in the Jackson test only. The cotton was seeded to a stand. Treatment number 1 was cultivated and chopped normally. Treatments 2, 3, 4, and 5 were regularly cultivated to control grass and weeds in the middles but were not chopped during the entire season. Treatments 6, 7, 8, and 9 were treated the same as 2, 3, 4, and 5 except that they were given one light chopping to kill the few weeds that survived the chemical treatments. Treatment 11 was a check with no treatment or chopping but with standard cultivation.

Water soluble dinitro controlled crabgrass and other annual weeds for about 5 weeks which was about 1 week short of the length of weed control obtained by this material in 1949. This is explained by the fact that the chemical is water soluble and can be leached by heavy rains. During the first 2 weeks after spraying in 1949, .43 inches of rain fell compared to 2.69 inches that fell over the same period of time in 1950 (Table III). It is important to note that even with an excess of rain, good weed control was obtained even though it lasted but 5 weeks.

TABLE I

YIELD IN POUNDS OF SEED COTTON PER ACRE FROM THE KNOXVILLE EXPERIMENT

Treatment Number*	Replication						Average
	1	2	3	4	5	6	
	pounds	pounds	pounds	pounds	pounds	pounds	pounds
1	1017	856	1029	1265	1042	1042	1042
2	769	806	818	732	1252	595	829
3	--	--	--	--	--	--	--
4	744	1004	1252	893	818	1277	988
5	--	--	--	--	--	--	--
11	248	285	149	74	112	236	186
	Least significant difference (5%)					----	286

Analysis of Variance**

Source of variation	D. F.	Sum of squares	Variance	F value
Treatments	2	152,070	76,035	1.54
Replications	5	90,181	18,036	.37
Error	10	492,615	49,262	
Total	17	734,866		

* Due to a lack of prior experience with oil soluble dinitro, treatments 3 and 5 were applied improperly by the writer causing the data from these two treatments in this experiment to be unreliable.

** Treatment number 11 was not included in the analysis.

TABLE II

YIELD IN POUNDS OF SEED COTTON PER ACRE FROM THE JACKSON EXPERIMENT

Treatment Number	Replication				Average
	1	2	3	4	
	pounds	pounds	pounds	pounds	pounds
1	1392	1668	1800	1620	1620
2	1260	732	1524	1860	1344
3	1224	960	1992	1764	1485
4	1488	1260	1512	2028	1572
5	1716	1728	1896	1224	1641
6	1788	1392	1668	1728	1644
7	1740	1572	1824	1680	1704
8	1572	1836	2088	1992	1872
9	1596	1692	1572	1872	1683
10	924	912	1764	1848	1362
				Least significant difference (5%)--	362

Analysis of Variance

Source of variation	D. F.	Sum of squares	Variance	F value
Treatments	9	925,448	102,828	2.59*
Replications	3	1,397,524	465,841	7.22**
Error	27	1,741,856	64,513	
Total	39	4,064,828		

* Significant.
** Highly significant.

TABLE III

WEATHER CONDITIONS FOR 14 DAYS FOLLOWING APPLICATION OF PRE-EMERGENCE SPRAYS AT THE U. S. COTTON FIELD STATION, KNOXVILLE

No. days after spraying	1949			1950		
	Temperature		Rain-fall	Temperature		Rain-fall
	Max. °F.	Min. °F.	inches	Max. °F.	Min. °F.	inches
1	88	53	.00	87	63	.00
2	92	54	.00	84	64	.00
3	94	58	.00	74	62	.64
4	87	57	.00	79	61	.25
5	90	59	.00	78	59	.00
6	80	62	.09	81	64	.13
7	78	59	.32	83	64	.11
8	68	56	.00	75	61	.20
9	80	50	.00	79	58	.40
10	82	52	.00	66	60	.06
11	84	52	.00	70	55	.65
12	88	56	.00	83	54	.00
13	88	60	.02	87	57	.00
14	86	60	.00	84	59	.25
Average	84.6	56.3	.43	80.0	60.1	2.69

TABLE IV

WEED CONTROL AND BOLL SIZE COMPARISON FROM THE KNOXVILLE EXPERIMENT

Treatment Number		Relative Weed Control	Weight of 20-boll sample. Average of 6 replications
			grams
1	Standard cultivation and chopping	Good	147.1
4	Dinitro and herbicidal oil	Good	146.8
2	Dinitro	Fair	136.3
11	Standard cultivation and no chopping	Poor(none)	123.5

Oil soluble dinitro gave a little longer control of weeds, which is reflected in the yields at Jackson (Table II). This is to be expected because it is not as soluble in water as the water soluble formulation, and hence is not so readily leached.

Both formulations of dinitro gave weed control that was comparable to the normally cultivated and chopped plots only when they were sprayed twice with an herbicidal oil. The combination of dinitro and herbicidal oil controlled the annual grasses and broad leaf weeds for a period long enough for the cotton to continue the control by shading. Herbicidal oil alone gave fair weed control but not as good as when it was used in combination with dinitro.

Twenty bolls were picked from each plot of treatment 1, 2, 4, and 11 for gin data. There was a difference in the size of bolls which the field observation shows to be caused by the presence or absence of weeds and not by the chemicals (Table IV). Data on lint percent, weight of 100 seeds, etc., were taken but showed only very small differences among treatments.

Cost of material is a factor to consider. Water soluble dinitro at present day prices, retails at about $1.75 per pound of active ingredient. Oil soluble dinitro retails at about $2.20 per pound. The herbicidal oils sell for about 25 cents per gallon. At these prices materials alone would cost $3.50 per acre for water soluble dinitro, $4.40 plus cost of fuel oil diluent for oil soluble dinitro, and $2.50 per acre for the two treatments of herbicidal oil, for strip treatment

covering only 1/3 of the field surface. The fuel oil diluent for the oil soluble dinitro retails at about 16 cents per gallon. It is impossible to give an accurate general figure for chopping an acre of cotton but it could easily be determined for any single producer.

Figure 1. Weed control in cotton with pre-emergence application of dinitro at the rate of 6 pounds per acre.

Plot on left treated 1 day after planting.

Plot on right untreated.

Figure 2. Close-up of the treated plot shown in Figure 1.

Figure 3. Close-up of the untreated plot shown in Figure 1.

Figure 4. View of a treated plot 6 weeks after planting. Treatment same as treated plot shown in Figure 1.

Figure 5. View at maturity of treated plot shown in Figure 1. Plot was cultivated but was not chopped.

Figure 6. View at maturity of untreated plot shown in Figure 1. Plot was cultivated but was not chopped.

CHAPTER V

SUMMARY

Four preliminary experiments were conducted in 1949, two at Knoxville and two at Jackson, with four chemicals, dinitro, PCP, IPC and 2,4-D as pre-emergence sprays in cotton. Dinitro was found to be the safest and most effective herbicide of the four, when used as a pre-emergence weed killer in this crop.

Two experiments were conducted in 1950, one at each of the above mentioned locations comparing water soluble and oil soluble dinitro with and without a post-emergence herbicidal oil treatment, and post-emergence herbicidal oil alone.

Water soluble dinitro, used as a pre-emergence spray at 6 pounds per acre for complete coverage or 2 pounds per acre when applied to the row only, controlled the annual grasses and most of the annual broad leaf weeds for a period of 5 or 6 weeks. Oil soluble dinitro gave control of weeds for a little longer period of time, which may not be economical when the extra cost of this formulation and the oil diluent is considered. Either of these treatments can be followed by one or two herbicidal oil sprays or with cultivation and a light chopping as the farmer may desire. However, the cost of the special equipment necessary to apply the herbicidal oil would probably limit this type of treatment to those growers with relatively large operations.

The following statement quoted from Hinkle, Buchele, and Stanton (12) can well serve as the final paragraph in this summary:

The decision as to whether to use a combination of pre-emergence and post-emergence treatments or post-emergence treatment alone will have to be made by the farmer. If satisfactory weather conditions prevail after planting such that the first post-emergence oil application can be made at the proper time, very satisfactory results will be obtained. However, if rainy conditions prevail making it impossible to apply the post-emergence oil applications at the proper time a pre-emergence weed control application made at planting time will provide control during this unfavorable period.

CHAPTER VI

CONCLUSIONS

The results of these experiments and similar experiments from most of the other cotton growing states, provide sufficient evidence that the use of dinitro either with or without herbicidal oil could be recommended safely to the cotton farmers of Tennessee for practical weed control. However, a farmer should try only a small acreage the first season to become acquainted with the material and the method of application which is very important to insure its success as a weed killer in cotton.

On the basis of this information, the Tennessee Experiment Station released tentative suggestions on the use of dinitro in Circular of Information No. 87, January, 1951, entitled "Chemical Weed Control in Cotton".

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