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The evaluation of certain treatments for weed control in tobacco plant beds

Gilbert N. Rhodes

To the Graduate Council:

I am submitting herewith a thesis written by Gilbert N. Rhodes entitled "The evaluation of certain treatments for weed control in tobacco plant beds." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

Eric Winters, Major Professor

We have read this thesis and recommend its acceptance:

Lawrence N Skold, E. J. Long

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

December 8, 1955

To the Graduate Council:

I am submitting to you a thesis written by Gilbert N. Rhodes entitled "The Evaluation of Certain Treatments for Weed Control in Tobacco Plant Beds". 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.

Eric Winters
Major Professor

We have read this thesis
and recommend its acceptance:

Lawrence V Skold

Erwin J. Long

Accepted for the Council:

E. G. Waters
Dean of the Graduate School

THE EVALUATION OF CERTAIN TREATMENTS FOR WEED CONTROL IN TOBACCO PLANT BEDS

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

Gilbert N. Rhodes

December 1955

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The success of a tobacco crop often depends upon an adequate supply of good, healthy plants available for early setting in the field. The control of weeds is a major factor influencing the number and quality of plants produced in the tobacco plant bed.

Until recent years, most plant beds were located on newly-cleared, wooded areas. This practice provided a soil of good tilth, of moderate fertility, and relatively free from weed seed. As these sites became scarcer, it became necessary to resort to locations previously used or to other areas which were usually contaminated with weed seed. Due to the many hours of labor required to hand weed a bed in these new areas, it was apparent that effective and economical means of weed control were needed. Three of the earlier methods used were burning materials on the plant bed soil, removal of one to two inches of surface soil, and steaming. Surface burning is still practiced by many but has been abandoned by some because of the limited supply of fuel. The removal of the surface soil has been abandoned because this practice eliminated too much of the top soil and allowed weed seed deeper in the profile to germinate after the top soil had been removed. Steam sterilization, although effective, has not been used much because of the expense.

During the past few years chemicals have been introduced and are in most cases proving effective for weed control in plant beds.

The two most widely used are calcium cyanamide and methyl bromide. Allyl alcohol has had limited use. Since these chemicals are now being used, it was decided that an evaluation be made under farm conditions over the East Tennessee Burley Tobacco area to evaluate these materials for weed control, stand of plants, and quality of plants.

Calcium cyanamide is sold in two forms: as a powder under the brand name Aero Cyanamid, and in the granular form as Aero Cyanamid, Granular (13)*. The granular form is the one most used for weed control in tobacco beds and the one used in this work. For simplicity and brevity, the term cyanamid will be used throughout the remaining part of this paper. It is a material that contains 21 per cent nitrogen and kills weed seeds on contact. It is black in color because of the presence of carbon and is distinctly alkaline, due to the presence of lime. One ton of cyanamid has a $CaCO_3$ equivalent of 1260 pounds basic (8).

Methyl bromide under pressure or at low temperatures is an odorless clear liquid but it quickly vaporizes at temperatures above 43° F. It disperses rapidly and has remarkable penetrating powers. Its killing action is rapid and it is quickly dissipated after fumigation is completed. The gas is three times as heavy as air. The material used in these investigations is known commercially as Dowfume MC-2 which contains 98 per cent methyl bromide and 2 per cent chloropicrin which acts as a warning agent (3).

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*Figures in parenthesis refer to "Literature Cited".

Allyl alcohol is a free flowing liquid with a pungent odor and is miscible with water. Allyl alcohol, sold under the brand name of Iscoweed, was used in these investigations (12).

CHAPTER II

REVIEW OF LITERATURE

Many of the chemicals tested for the control of weeds in tobacco plant beds have given good weed control but only methyl bromide, cyanamid, and cyanamid and urea have found widespread use. Other chemicals cause mechanical difficulties in application or have adverse influence on plant growth.

In 1943, Carr (5) of the Georgia Coastal Agricultural Experiment Station reported that as an average of three years' work one pound of cyanamid per square yard controlled 87 per cent of the weeds, and 215 plants per square yard were suitable for transplanting.

Abbott (1) reported that cyanamid applied in the fall at the rate of one pound per square yard and worked into the soil to a depth of 5 inches effectively prevented germination of weed seeds in tobacco plant beds.

Bullock (4) reported an average of 17.9 weeds and 158 tobacco plants per square foot on beds treated with one pound of cyanamid per square yard.

Henderson, Matthews, and Jenkins (10) suggested the use of one pound of either urea or cyanamid or a combination of one pound of urea and one-half pound of cyanamid per square yard of plant bed area. They stated that the treatment would not give complete control of weeds but would reduce the number of weeds to such an extent that with a little hand weeding an excellent crop of plants could be grown on soil

infested with weed seeds.

Clark and Volk (7) reported that either one pound of urea or one pound of cyanamid per square yard has given good weed control and excellent plants. They stated that the chemically treated soils have produced plants much earlier for transplanting than non-treated soils.

Chappel and Laprade in 1955 (6) reported that weed control was obtained in tobacco beds by the use of several chemicals. Methyl bromide proved to be the most consistent and resulted in no injury to the plants. Allyl alcohol applied in either spring or fall also resulted in good weed control with little or no injury. Cyanamid gave good weed control but caused injury to the plants under some conditions.

Hill, Klingman, and Woltz (11) have done much work with chemicals for weed control in tobacco plant beds. They found that white clover and Kobe lespedeza predominated rather consistently in all cyanamid treated plots. Where methyl bromide was used there was no significant difference in total weed control between a fall and spring application. The fall application of methyl bromide failed to control red clover and white clover. These clovers were effectively controlled by the spring application of methyl bromide.

Allyl alcohol gave a high degree of weed control on all species except jerusalem oak.

On a Norfolk soil, methyl bromide was the most effective herbicide tested. This chemical gave a high degree of control of all species. Allyl alcohol compared favorably with methyl bromide for the control of all weed species except jerusalem oak.

CHAPTER III

EXPERIMENTAL PROCEDURE

The work reported here was done over a two-year period at several locations. The major objectives were to compare certain treatments for weed control in tobacco plant beds, to observe the effects upon stand of plants, and to determine which treatment provided the best quality of plants at setting time.

Representatives of The American Cyanamid Company, The Larvacide Chemical Company, and The Dow Chemical Company cooperated by furnishing the weed control chemicals and by assisting with the application of the materials. Certain County Agricultural Agents and farmers in East Tennessee Counties cooperated by assisting with the investigations.

In the fall of 1953, investigations were conducted at twenty-two locations in twenty different counties. The materials used were methyl bromide, allyl alcohol, and cyanamid. In the fall of 1954, investigations were conducted at eleven locations in eleven different counties. The materials used were methyl bromide and cyanamid with observations being made on burned beds and untreated checks where possible. Allyl alcohol was not included in the 1954 investigations because of the irritating effect it had on the eyes and nose the previous year.

A single plot or plant bed was treated with each material at each location. All plots were 9 x 50 feet, except the six untreated check plots which were 9 x 4 feet. The plots were either arranged end to end

or side by side. When the plots were arranged side by side, a two-foot walkway was left between the plots to facilitate drainage and to avoid the movement of chemicals between them.

The plots were treated during the period from September 15 to October 15. This range in dates was recommended by the American Cyanamid Company (2) as being most satisfactory for the use of cyanamid. Heggestad (9), who has done work previously with these chemicals, indicated that these dates were most satisfactory for using methyl bromide and allyl alcohol as well as for cyanamid.

The soil in all plots was thoroughly prepared before treating. At the different locations, the methods used in preparing the soil varied somewhat due to the different implements employed. But in each case before treating, the soil was worked to a depth of four to five inches and made as free of clods as possible.

Cyanamid was used at the rate of one and one-half pounds per square yard and was applied in two equal applications. One-half of the material was worked into the top three inches of soil, and the remaining one-half was then worked into the surface to a depth of about one inch.

Five one-pound cans of methyl bromide were used for each 9 x 50 foot plot. A gas-proof plastic cover was used to hold the gas on the bed for 24 to 48 hours. Since methyl bromide is poisonous, a special type applicator was used to release the liquid to protect the operator from exposure to the fumes.

Three quarts of allyl alcohol were used for each 9 x 50 foot plot. This amount of material was mixed with 100 gallons of water and applied

as a drench with a two-gallon sprinkling can. This amount of solution was sufficient to wet the soil to a depth of approximately two inches.

At sowing time each cooperator was instructed to use only one-half pound per square yard of 0-12-12 fertilizer, or its equivalent, on the cyanamid treated plots and one-half to three-fourths pound of 4-12-8, or its equivalent, on the methyl bromide and allyl alcohol treated plots, these being the recommended rates of fertilization (14). They were instructed to sow seed at the rate of one to one and one-half level teaspoons for each 9 x 50 foot plot.

Since the objective of this work was to evaluate these materials under actual field conditions, the cooperating farmer actually performed all operations of soil preparation, fertilizing, sowing and care of the plant bed until transplanting, careful instructions having been given on the best methods for performing these operations. The author assisted the cooperator with the application of chemicals.

Examination of beds was made soon after plant emergence to determine weed control and stand of plants. Weed and plant counts were made at four different places in each plot. According to a prearranged plan these counts were made at 9, 18, 27, and 36 feet lengthwise and 2 feet from the side toward the center. A one-foot square wire marked into four sections was placed at these locations to facilitate the counting.

At setting time the cooperators were asked which method, cyanamid, methyl bromide, or allyl alcohol, produced the best plants for transplanting.

CHAPTER IV

RESULTS

The performance of each chemical treatment was evaluated by measuring stand of plants, weeds present in plant bed, and quality of plants at setting time, the latter being appraised qualitatively by the cooperator.

Stand of Plants

The twenty-two locations treated in the fall of 1953 had an average of 58.3 plants per square foot for the cyanamid treated plots, 70.1 for the methyl bromide, and 50.2 for the allyl alcohol (Table I). There was considerable variation in results from county to county, however, and the only statistically significant difference in stand was between methyl bromide and allyl alcohol. Data in Table II show that in the eleven comparisons between cyanamid and methyl bromide in the fall of 1954 there was no significant difference in stand of plants although the cyanamid treated plots averaged 58.2 and the methyl bromide 73.1 plants per square foot.

According to Nichols (15) a good stand of tobacco plants exists when there are fifty to 100 plants per square foot. This information indicates the average number of plants per square foot for each treatment was satisfactory (Tables I and II). However, of the twenty-two comparisons in 1953 in Table I, eight of the cyanamid treated plant beds, ten of the allyl alcohol and only three of the methyl bromide

TABLE I

STAND OF PLANTS AND WEED COUNT IN TOBACCO PLANT BEDS IN THE SPRING OF 1954 RESULTING FROM TREATMENT WITH CYANAMID, METHYL BROMIDE, AND ALLYL ALCOHOL IN THE FALL OF 1953

Location of cooperator (County)	Plants per square foot*			Weeds per square foot*		
	Cyanamid	Methyl Bromide	Allyl Alcohol	Cyanamid	Methyl Bromide	Allyl Alcohol
Franklin	71.8	116.0	61.0	2.8	1.3	2.0
Moore	36.5	71.3	52.8	1.5	1.8	0.5
Coffee	31.8	68.0	49.8	2.5	2.5	12.3
Roane	84.5	55.5	66.5	8.0	16.5	4.8
Grainger	81.5	63.0	70.5	7.8	5.3	8.0
Union	69.7	104.5	79.0	2.0	2.5	3.8
Sullivan	70.0	70.3	70.0	3.5	4.8	5.8
Carter	150.0	115.0	56.6	8.3	5.3	9.3
Unicoi	58.5	71.0	49.3	2.3	2.8	3.8
Hancock	55.3	61.3	102.3	7.8	22.8	16.0
Greene	62.0	45.5	45.3	3.5	3.5	8.0
Hawkins	8.8	50.0	4.0	0.0	0.0	0.0
Rhea	54.0	53.8	37.5	4.3	2.3	4.3
Meigs	64.3	67.5	59.3	13.0	3.0	6.0
Loudon	36.3	17.5	21.8	3.0	3.8	1.5
Loudon	34.5	52.3	35.3	3.5	1.8	0.5
Loudon	44.3	60.0	60.0	52.0	4.5	11.0
Grundy	113.5	143.0	59.0	32.0	7.5	24.0
Bradley	24.8	45.0	24.0	34.5	2.0	17.5
McMinn	0.0	110.8	0.0	0.0	11.3	0.0
Warren	82.5	90.3	86.3	1.3	0.8	1.0
Van Buren	60.0	60.0	15.0	110.0	23.5	40.5
Average	58.8	70.1	50.2	13.8	5.9	8.2
Least significant difference (5%)			13.4	No significant difference		
(1%)			18.0			

*Each figure reported is the average of four counts per plot.

TABLE II

STAND OF TOBACCO PLANTS IN THE SPRING OF 1955 RESULTING FROM TREATMENT WITH CYANAMID, METHYL BROMIDE, AND BURNING IN THE FALL OF 1954

Location of cooperator (County)	Plants per square foot*			
	Cyanamid	Methyl Bromide	Burning	Untreated check
Anderson	45.8	45.8	39.0	-
Blount	46.3	71.0	25.0	-
Franklin	61.8	49.0	-	42.0
Hamblen	75.0	81.3	-	101.2
Loudon	62.0	136.3	83.3	-
McMinn	29.8	77.0	90.0	48.0
Monroe	36.0	69.0	-	-
Polk	77.5	58.8	57.8	32.3
Sullivan	76.3	72.8	-	60.0
Union	56.3	51.3	-	-
Van Buren	73.5	92.0	-	-
Average	58.2	73.1	-	-
No significant difference between cyanamid and methyl bromide treatments				
Average (5 loc.)	52.3	77.8	59.0	-
Average (5 loc.)	59.4	67.0	-	57.1

*Each figure reported is the average of four counts per plot.

had less than fifty plants per square foot. Data in Table II show that four of the eleven beds treated in 1954 with cyanamid and two of eleven treated with methyl bromide had less than fifty plants per square foot.

The plant beds in McMinn County treated with cyanamid and allyl alcohol produced no plants while the methyl bromide plot produced 110 plants per square foot (Table I). The Hawkins County location produced 8.8 plants per square foot on the cyanamid treated plot and 4.0 on the allyl alcohol treated plot compared to 50.0 on the methyl bromide treated plot (Table I). The reasons for the failure to obtain a stand of plants on the cyanamid and allyl alcohol treated plots at these two locations were never determined. Since both locations were in sod fields, it is possible that soil insects might have caused the failures. Methyl bromide is toxic to insects in the soil at time of treatment; whereas, cyanamid and allyl alcohol are not. It is also possible that the toxic effects of cyanamid and allyl alcohol had not completely disappeared as the soils were of heavy texture at both locations.

The five plots that were burned produced a stand of plants that was acceptable on the average, however, two of the five plots produced less than fifty plants per square foot (Table II).

The five untreated check plots produced an average stand of 57.1 plants per square foot as compared to 59.4 for cyanamid and 67.0 for methyl bromide. However, three of the five untreated check plots produced less than fifty plants per square foot (Table II).

Weed Control

Examination of Table I reveals that the methyl bromide treatments gave a lower weed count per square foot (5.9) than did the cyanamide (13.8) or allyl alcohol (8.2) treatments. However, analysis shows that these differences were not statistically different.

There was a significant difference between the plots treated with cyanamid and methyl bromide the second year as reported in Table III. Methyl bromide was significantly better than cyanamid having only 2.7 weeds per square foot as compared to 11.0 for cyanamid.

Further examination of Table III shows that excellent weed control was obtained by burning at the five locations where this control method was compared with cyanamid and methyl bromide treated plots. The six locations where cyanamid and methyl bromide treatments were compared with untreated checks showed an average of 9.5, 1.9, and 61.7 weeds per square foot respectively, illustrating the importance of using some satisfactory weed control method.

Plant Quality

A majority of the cooperators reported the methyl bromide treatment to be superior in providing good quality plants for transplanting. These opinions are summarized in Tables IV and V.

TABLE III

WEED COUNT IN TOBACCO PLANT BEDS IN THE SPRING OF 1955 RESULTING FROM TREATMENT WITH CYANAMID, METHYL BROMIDE, AND BURNING IN THE FALL OF 1954

Location of cooperator (County)	Weeds per square foot*			
	Cyanamid	Methyl Bromide	Burning	Untreated check
Anderson	14.0	4.8	12.0	-
Blount	8.3	2.0	3.8	-
Franklin	5.0	4.0	-	120.5
Hamblen	12.0	0.8	-	28.7
Loudon	7.5	4.5	0.3	-
McMinn	6.5	3.0	0.5	42.0
Monroe	14.8	1.8	-	55.5
Polk	16.8	1.0	1.5	103.5
Sullivan	2.0	0.8	-	20.0
Union	31.0	2.5	-	-
Van Buren	2.5	4.7	-	-
Average	11.0	2.7	-	-
Least significant difference between cyanamid and methyl bromide (5%) 5.9				
Average (5 loc.)	10.6	3.1	3.6	-
Average (6 loc.)	9.5	1.9	-	61.7

*Each figure reported is the average of four counts per plot.

TABLE IV

COOPERATORS OPINION AS TO THE TREATMENT WHICH PROVIDED THE BEST QUALITY OF PLANTS FOR TRANSPLANTING IN THE SPRING OF 1954

Location of cooperator (County)	Quality for Transplanting		
	Cyanamid	Methyl Bromide	Alcohol
Rhea	equal	equal	poorer
Meigs		best	
Loudon	best		
Loudon	poorer	equal	equal
Loudon		best	
Bradley		best	
Warren		best	
Coffee	best		
Roane	poorer	equal	equal
Franklin	poorer	equal	equal
Moore	poorer	equal	equal

TABLE V

COOPERATORS OPINION AS TO THE TREATMENT WHICH PROVIDED THE BETTER QUALITY OF PLANTS FOR TRANSPLANTING IN THE SPRING OF 1955

Location of cooperator (County)	Quality for Transplanting	
	Cyanamid	Methyl Bromide
Anderson		better
Blount	equal	equal
Franklin		better
Hamblin		better
Loudon		better
McMinn	better	
Monroe		better
Polk		better
Sullivan		better
Union		better
Van Buren	better	

Cost of Material

Cost of materials for plant bed treatment is a factor to consider. Costs are variable but at the time this work was done, the retail price of cyanamid was $4.50 per hundred pounds, allyl alcohol $6 per gallon, and methyl bromide $.85 per one pound can. For using methyl bromide an applicator and plastic cover are needed which cost $4.50 and $13 respectively. At these prices the cost of materials to treat a plot 9 x 50 feet would be: cyanamid $3.38; methyl bromide, $4.25 (plus $17.50 for equipment, the cost of which can be depreciated over a number of years); and allyl alcohol, $4.50.

Labor Requirements

The total hours of labor required to make the different chemical treatments are relatively the same. However, the methyl bromide treatment requires two men to place the plastic cover over the bed.

According to Ranney (16) 35.5 hours of labor are required to prepare, burn, sow and manage a plant bed to produce sufficient plants to set one acre of burley tobacco as compared to 8.5 hours of labor required for a chemically treated bed.

CHAPTER V

SUMMARY AND CONCLUSIONS

The major objectives of this study were to evaluate certain treatments for weed control in tobacco plant beds, to observe the effects upon stand of plants, and to determine which treatment provided the best quality of plants at setting time. In the fall of 1953, investigations were conducted at twenty-two locations in the Burley Tobacco Area of East Tennessee and in the fall of 1954 at eleven locations.

Data for the two years show no significant difference in stands of plants between plots treated with cyanamid and methyl bromide. The only significant difference was between the methyl bromide and the allyl alcohol treated plots the first year. Treatment with methyl bromide resulted in stands with fifty or more plants per square foot more frequently than did treatment with cyanamid or allyl alcohol.

The five plots that were burned produced stands of plants that were acceptable on the average, however, two of the five plots did not produce stands of fifty or more plants per square foot.

The five untreated check plots produced stands of plants that were acceptable on the average; however, three of the five untreated check plots did not produce stands of fifty or more plants per square foot.

Treatment with methyl bromide resulted in a lower weed count per square foot than did the cyanamid or allyl alcohol treatment. The

difference was not significant at 5 per cent level the first year but was the second year.

Burned plots at the five locations compared favorably with the methyl bromide treated plots for weed control.

The high weed population present in untreated check plots points out the necessity for adequate weed control methods.

A majority of the cooperators reported the methyl bromide treatment to be superior to other treatments in providing good quality plants for transplanting.

This work indicates that methyl bromide and cyanamid can be used successfully for weed control in tobacco plant beds. Methyl bromide was more consistent at a majority of the locations in giving good weed control, stand of plants, and quality of plants for transplanting than was cyanamid. However, the cost for applying methyl bromide is greater and for this reason some growers will prefer to use cyanamid.

Allyl alcohol was satisfactory for the purpose for which it was being evaluated, but due to its toxicity to man it cannot be safely recommended for use by tobacco growers.

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