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The effects of diphenamid, trifluralin and EPTC on the control of weeds and the yield and quality of burley and fire-cured tobacco

Hubert F. Ottinger

To the Graduate Council:

I am submitting herewith a thesis written by Hubert F. Ottinger entitled "The effects of diphenamid, trifluralin and EPTC on the control of weeds and the yield and quality of burley and fire-cured tobacco." 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.

Henry Andrews, Major Professor

We have read this thesis and recommend its acceptance:

H.C. Smith, R.S. Dotson

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Carolyn R. Hodges

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

September 16, 1965

To the Graduate Council:

I am submitting herewith a thesis written by Hubert F. Ottinger entitled "The Effects of Diphenamid, Trifluralin and EPTC on the Control of Weeds and the Yield and Quality of Burley and Fire-Cured Tobacco." 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.

Henry Andrews
Major Professor

We have read this thesis and recommend its acceptance:

Horace C. Smith

Robert L. Dotson

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Dean of the Graduate School

THE EFFECTS OF DIPHENAMID, TRIFLURALIN AND EPTC ON THE CONTROL OF WEEDS AND THE YIELD AND QUALITY OF BURLEY AND FIRE-CURED TOBACCO

A Thesis

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Master of Science

by

Hubert F. Ottinger

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CHAPTER I

INTRODUCTION

To produce an acre of either burley or fire-cured tobacco (*Nicotiana tabacum*) in Tennessee, 350 to 450 man hours of labor are required. Of the total, 20 to 30 man hours per acre are normally required for cultivations and hoeing (29). The actual time involved depends upon weediness and the relative effectiveness of the cultivation. Often these hoeings and cultivations result in root damage, disease transmission, and leaf injury which may reduce the yield and quality of the cured leaf.

Parris (28) estimated that tobacco growers in Tennessee experience a loss of $1,350,000 annually due to weeds. This loss estimation includes only the cost of weed control in plant beds and the loss of yield in field tobacco. Factors such as loss due to extra land preparation were excluded. This figure could be lowered if more effective and efficient means of weed control could be developed.

Research in the area of chemical weed control on field grown tobacco has been accelerated in an effort to decrease man hours required so as to lower the production cost. This would make it possible for domestic American tobaccos to compete with tobacco grown in other regions of the world on a more equal footing (23). If the per acre production cost could be lowered enough, some corresponding decrease in the gross dollar returns might prove more tolerable to the growers.

This can be especially true in instances where disease is a problem and where a minimum of soil and plant contact or translocation may be desired.

The objectives of this study were to determine:

1) by visual ratings the relative effectiveness of three selected herbicides upon the growth of weeds in tobacco;

2) the effects of the herbicides upon the yield and quality of tobacco; and

3) the most effective of the herbicides tested for use in the production of burley and dark fire-cured tobacco.

CHAPTER II

REVIEW OF LITERATURE

The use of herbicides in the control of weeds in field tobacco has only recently developed since few chemicals have been found to be both effective and selective weed eliminators for tobacco. Actual field trials have been studied for only six or seven seasons. Consequently chemical weed control usage has been limited largely to plant beds (8).

Cunningham (8) stated that in the late 1940's, Wilson and Klingman in North Carolina, found that pentachlorophenol (PCP) gave indication of having practical capabilities.

Coggins, et al. (7) in 1953 concluded from their experiments on flue-cured tobacco that cultivation increased the yield of tobacco only by weed elimination. The yield difference between scraped and cultivated plots was not significant. It was also found that PCP at 20 pounds per acre detrimentally affected tobacco.

Klingman (21) while experimenting with several herbicides near Clayton, North Carolina, found that 2-chloroallyl diethyl-dithiol carbamate (CDEC), 2-chloro-N,N-diallylacetamide (CDAA), and sodium, 2,4-dichlorophenoxyethyl sulfate (2,4-DES) with cultivation on fine sandy loam soil gave effective weed control without injury to the flue-cured tobacco involved. Reasons for not pursuing study of these chemicals further were not explained.

DeHertogh, et al., (11) applied ethyl N,N-di-n-propyl-thiol-carbamate (EPTC) and several of its analogs; propyl N,N-di-n-propyl-thiolcarbamate (vernolate); ethyl N,N-ethyl-n-butylthiol-carbamate (R-2060); propyl N,N-ethyl-n-butyl-thiol-carbamate (pebulate); O-(2,4-dichlorophenyl)O-methyl isoprophylphosphoramidothioate (DMPA); 3-amino-2,5-dichlorobenzoic acid (amiben); 2-chloro-4-diethyl-amino-6-ethylamino-s-triazine (trietazine); and the dimethyl ester of 2,3,5,6-tetrachloro-terephthalic acid (DCPA) to tobacco. They found that EPTC, vernolate, R-2060, pebulate, and DMPA gave relatively effective weed control on clay and sandy loam soils. EPTC performed as well or better than any of its analogs. Some injury was noted on flue-cured tobacco when 3 pounds per acre of EPTC were incorporated prior to transplanting. This, DeHertogh felt, was due to cold, wet weather.

Smith and Andrews (30), during the 1961 season, experimented with EPTC, DCPA, DMPA, and amiben on burley and dark fire-cured tobaccos. They found that only EPTC gave excellent weed control at all locations in Tennessee.

Freeman and Dubey (14) in 1962 observed that burley tobacco was tolerant to EPTC, vernolate, N,N-dimethyl-2,2-diphenyl, acetamido (diphenamid), and 2,6-dichloro-benzonitrile (casoron) when applied broadcast 10 to 20 days after transplanting. Further conclusions were that granular applications were more effective than liquid applications and that persistence of diphenamid killed fall seeded small grains.

In 1963 Cunningham (8) found that EPTC at 3,4, and 6 pounds per acre, diphenamid at 4 and 6 pounds per acre, and a,a,a,-trifluro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) at 2,3,4, and 6 pounds per acre gave good weed control at four locations in Tennessee on silt loam, silty clay loam and clay loam soils. With the exception of diphenamid, herbicide activity was increased by incorporation. Diphenamid was especially effective in controlling grassy weeds, but the common morning-glory (*Ipomoea purpurea*) was not controlled.

Vernolate, and trifluralin gave either tobacco plant injury or poor weed control at all locations. Cultivation treatments were superior in value per acre and yield per acre in all trials with the exception of EPTC on dark fire-cured tobacco. All other herbicide treatments reduced dollar per acre values as much as $230 to $250 per acre when compared to the cultivated treatment.

Klingman (23) reported in 1964 that effective weed control, without injury to tobacco, was possible with diphenamid, vernolate, and a mixture of trifluralin and diphenamid. Bennett, et al. (5) as reported by Klingman (23), while pursuing an extension demonstration program, found no significant differences for yield and value between cultivation, diphenamid, and a combination of diphenamid and trifluralin treatments. It was further concluded that there was a tendency toward increased yield per acre and a decrease in price per acre as the number of cultivations were reduced.

HERBICIDE REVIEW

EPTC

EPTC is virtually a clear liquid with an aromatic odor. It is slightly soluble in water and infinitely soluble in most organic solvents including benzene, toluene, xylene, acetone, isopropanol, and methanol. The boiling point of the material at 20 mm. mercury is 127^{o}C. It is quite stable and apparently non-corrosive. No adverse effects have been observed in the handling of EPTC during production or in laboratory and field testing (31).

EPTC is considered relatively safe to humans. Summarized investigations indicate that this material has an acute dermal LD-50 (lethal dose to 50 per cent of population) of 10,000 milligrams per kilogram of body weight of male albino rabbits. The acute oral LD-50 is 1630 milligrams per kilogram of body weight (22).

The herbicidal activity of EPTC is related to several related factors. Antognini (1) found indications that soil moisture at the time of application of EPTC played a decisive role in the variability of field results. Data showed that poor weed control was associated with wet soil.

Another factor related to activity of EPTC is soil incorporation. Menges (26) found that EPTC phytotoxicity was increased when sprinkler irrigation followed chemical application as compared to subirrigation.

In 1958, Klingman, et al. (24) while experimenting with EPTC and methods of its application, found that treatments incorporated by rainfall consistently gave better weed control results than non-incorporated treatments or treatments applied to crusted soil. Antognini, et al. (2, 3, 4) obtained excellent weed control results when EPTC was incorporated with a disc, spike tooth harrow, or rotary cultivator prior to planting or immediately following planting. With postemergence applications, ordinary cultivation equipment served as a suitable incorporator. They concluded that the incorporation of EPTC minimized experimental variation which had resulted from differences of soil moisture, soil tilth, additional rainfall, and other environmental factors. Antognini, et al. (4) also suggested the possibility of combining EPTC with an insecticide, applying the two simultaneously, incorporating them, and thus eliminating one operation.

Hooks and Klingman (19) found in North Carolina that the most reliable method of herbicide soil incorporation was achieved by the use of a power-driven rotary cultivator. They noted that EPTC, pebulate, DCPA, DMPA, and trifluralin gave satisfactory weed control when incorporated two inches into the soil. When EPTC was incorporated pre-transplant, some tobacco injury resulted.

EPTC was found injurious to burley tobacco when applied as a granule but not as a liquid. The difference between yield and value per acre of cultivation treatments and of the EPTC-treated plots on dark fire-cured tobacco, according to Cunningham (8, 9), was not significant; but widely varying results occurred on burley.

According to Hauser and Parham (18) the depth of incorporation and method of application of EPTC is important as it is related to its phytotoxicity. In greenhouse experiments it was found that when the material was placed at a 1.5 inch depth by subsurface equipment, the weed control effectiveness was greater than when the chemical was applied at lesser depths. It was further concluded that subsurface applications were more effective in eliminating weeds than were the incorporated type of treatments.

The effects of organic compounds in the soil on EPTC have been investigated by Danielson, et al. (10). It was found that organic materials located in or added to the soil increased the persistence of this chemical.

Jordan and Day (20) found that toxicity of EPTC and organic matter in the soil had a close inverse relationship. The tocicity of EPTC to oats (*Avena sativa*), sesbania (*Sesbania macrocarpa*) and nutsedge (*Cyperus rotundus*) was found to be negatively correlated with the organic matter content of the soil, but a positive correlation was found between the sand and silt content.

Trifluralin

Pure trifluralin will crystallize in yellow-orange prisms and when subjected to heat will melt between 48.5 and 49°C. It is readily soluble in organic solvents such as acetone and xylene, but its solubility in water is less than 1 ppm. at 27°C. Also, trifluralin is susceptible to decomposition by ultraviolet irradiation (13).

Toxicological evaluation of trifluralin indicates that it has a wide margin of safety to mammals and chickens. Worth and Anderson (38) observed that single oral doses to mice, rats, rabbits, dogs, and chickens indicate the LD-0 to be greater than 10 grams per kilogram of body weight.

Experiments to determine the effect of trifluralin upon the breeding and reproduction of rats was positively concluded. The parent generation raised six litters in 540 days with no abnormalities. A daily diet with 2000 p.p.m. of trifluralin was fed to all experimental animals (38). Observations of the third generation were not reported.

The testing of trifluralin on soybeans (Glycine max) and cotton (Gossypium hirsutum) was rather frequently noted in literature reviewed. Oliver (27) noted soybean injury at any rate of trifluralin greater than 1 pound per acre. Talbert (33) noted lateral root injury on snapbeans (Phaseolus vulgaris) and after investigation theorized the principle mode of action of trifluralin to be a mitotic poison.

Diphenamid

Pure diphenamid is moderately soluble in acetone, dimethyl formamide and phenyl cellosolve. Its solubility in water at 27°C. is 260 p.p.m. The material is rather resistant to ultraviolet irradiation but some decomposition is noted when it is exposed to temperatures in excess of 210°C. (12).

The single acute oral LD-50 for rats of the 80 per cent wettable powder is 1200 milligrams per kilogram of body weight. Two and one-half grams per kilogram of the material were held in contact with the bared skin of rabbits for 24 hours and no deaths occurred. A slight redness appeared. No irritation was evident when a 1 per cent suspension was dropped into rabbit's eyes (12).

Diphenamid is readily absorbed and easily moved within plants. More of the material is found in the basal area of a plant than in the meristematic region (12).

Wright, et al. (39) found that diphenamid gave good preemergent control against all seedling grasses and against pigweed (*Amoranthus* sp.) and smartweed (*Polygonum* sp.). The control of jimsonweed (*Datura stramonium*) and ragweed (*Ambrosia* sp.) was poorer than the grass control. It was found that diphenamid had no effect on established seedlings.

Under dry conditions, some mechanical soil incorporation was found to improve the phytotoxicity of the herbicide. Experimental observations indicated that about one-half inch of rainfall or water from a sprinkler irrigation soon after application have improved the weed killing effectiveness. This moves the chemical into the germination zone of weeds; however, excessive irrigation or rainfall may leach the herbicide out of a sandy soil and decrease its weed killing effect (12).

Diphenamid will persist in the clay or silt soils and frequently small grains are killed in the fall following a crop previously treated with the material. Fall seedlings of alfalfa (*Medicago sativa*) and birdsfoot trefoil (Lotus corniculatus) can be made; however, without fear of phytotoxic stress to the seedlings (12).

CHAPTER III

MATERIALS AND METHODS

Edaphic Variations and Location

Experiments were carried out at three different locations across the state in 1964, to evaluate the effects of herbicides on weeds and on the yield and quality of tobacco under different soil and environmental conditions.

They were located on Cumberland silt loam at the Tobacco Experiment Station near Greeneville, on Dickson silt loam at the Highland Rim Experiment Station near Springfield and on Armour silt loam at the Middle Tennessee Experiment Station near Spring Hill

At the Greeneville location an additional experiment was applied using the same herbicides used at other locations. The objective was to determine if yield and quality of burley tobacco were affected by herbicide application if weeds were eliminated by cultivation and hoeing.

Design of Experiment

In all experiments a randomized complete block design with four replications was used. Plots at the Springfield location on fire-cured tobacco were four rows wide, sixty feet long with twenty plants per row. Rows were spaced three and one-half feet apart. Plots four rows wide, forty-three feet and nine inches long with thirty-five plants per row were used in tests at the Greeneville and Spring Hill locations on burley tobacco.

Cultural Aspects

Cultural practices recommended for maximum production from selections of variety and plant bed preparations to grading and marketing were used. Soil test and cropping history were used as the basis for determining amounts of fertilizer applied.

The cultivation treatments were hoed and cultivated with a sweep type cultivator to maintain 100 per cent weed control as nearly as possible. The herbicide-treated plots were not hoed or cultivated, excepting as indicated in the tables.

Herbicides

Diphenamid, trifluralin, EPTC, and a mixture of diphenamid and trifluralin were the chemicals used in the experiments. A mixture of trifluralin and diphenamid also was used in an effort to broaden the weed control spectrum.

The herbicides and rates used in this experiment were those which had previously given some indication of being of economic value to tobacco growers (Table 1). These were materials that had shown some promise in areas other than the burley tobacco belt. According to some researchers, quite favorable responses had been obtained and were expected from using the herbicides used in this test.

TABLE 1

TREATMENTS APPLIED TO 1964 FIELD EXPERIMENTS WITH BURLEY AND FIRE-CURED TOBACCO AT GREENEVILLE, SPRINGFIELD AND SPRING HILL

Treatment	Rate lb./A active ingredient	Location
Cultivation	-	All locations
Trifluralin pre-transplant incorporated	1	All locations
Trifluralin and diphenamid pre-transplant incorporated	1/2 + 3	All locations
Trifluralin and diphenamid pre-transplant incorporated	3/4 + 3	All locations
Trifluralin and diphenamid pre-transplant incorporated	1 + 3	All locations
EPTC pre-transplant incorporated	3	All locations
Diphenamid post-transplant plus one cultivation	6	All locations
Diphenamid post-transplant	6	All locations
Diphenamid post-transplant band applied	3	Springfield only

At the Greeneville location two different tests and eight treatments were pursued (Table 1). The tests were identical except that one received chemical treatments plus cultivation, while the other received chemical treatments alone. Cultivating the one test was to evaluate the effects that the specific chemicals would have upon the yield and value of the burley tobacco if weed competition was eliminated. Each location had a cultivated check where no herbicide was applied for the purpose of comparison.

Application of Herbicide

Herbicides were applied as pre-transplant or post-transplant and broadcast except for one treatment at Springfield using a post-transplant band application (Table 1). Applications were made on 29 May 1964 at Greeneville, 4 June 1964 at Springfield and on 5 June 1964 at Spring Hill. Soil incorporation was achieved by a sweep type cultivator at Greeneville and Spring Hill and a disc harrow at Springfield. Incorporation was to a depth of 2 to 4 inches immediately after application of the herbicide.

All formulations of herbicides were applied as an aqueous spray from a tractor-mounted sprayer delivering 28 gallons of spray per acre at a pressure of 40 pounds per square inch. The sprayer nozzles were spaced 20 inches apart and were of the 80 degree flat-spray type.

Observations and Ratings

Tobacco weed control ratings were made visually and recorded. Ratings were made of each replication at each location on 1 August and 27 August 1964. The ratings of the replications were averaged to give an average weed control of a specific treatment at each location. Weed control ratings were made on an arbitrary 0 to 10 scale with a lack of weed control being 0 and perfect control being 10.

Yield and Value

Only the tobacco from the most promising treatments was harvested for yield and value per acre. The two middle rows from the four row plots were harvested and kept separate through curing and grading. Weight per plot was recorded and yield per acre and grade determinations were made for each individual plot.

The tobacco was given standard grades by Federal graders. The price per pound was based on 1963 average auction prices for each grade (34, 35). The acre values were calculated from the yields and price for the grades.

Statistical Analysis

An analysis of the yield and value returns of the harvested tobacco was made. The analysis of variance technique for a randomized complete block design was used for statistical computations (32, 36). Where the F test showed a significant difference at the desired level (0.10) of probability, a comparison between treatment means was made using Duncan's Multiple Range Test (17, 36).

CHAPTER IV

RESULTS AND DISCUSSION

The results of the 1964 experiments of chemical weed control in tobacco are given and discussed by locations.

Greeneville

At this location the treatments receiving herbicides only were not harvested since weed growth was not controlled. Figures 1 and 2 show luxurious weed growth. Pigweed (*Amoranthus hybridus*) and morning-glory were prominent. The figures shown are typical examples of the lack of weed control in the treatments which received only herbicides. Weed control ratings are not included since early in the season it was evident that weeds were not controlled.

The herbicide test that was also cultivated was harvested for yield and quality determinations. Data in Table 2 show that there are no significant differences of yield and value between the treatments.

EPTC continued to give rather erratic results. At this location, EPTC treated plots gave results not significantly different than the cultivation only and the diphenamid plus one cultivation. The difference of $54 per acre was not significant at the 0.10 level of probability.

Trifluralin, when applied at the rate of 1 pound per acre plus cultivation, resulted in good weed control. The rate of 1 pound per acre was used since previous experiments resulted in tobacco plant

Figure 1. Diphenamid applied post-transplant to burley tobacco at the rate of 6 pounds per acre at the Tobacco Experiment Station, 1964. Average weed control rating of 0.

Figure 2. Trifluralin applied pre-transplant incorporated to burley tobacco at a rate of 1 pound per acre at the Tobacco Experiment Station, 1964. Average weed control rating of 0.

TABLE 2

AVERAGE PRICE PER POUND, YIELD AND VALUE PER ACRE OF BURLEY TOBACCO RECEIVING VARIOUS TREATMENTS, GREENEVILLE, TENNESSEE, 1964 (ALL TREATMENTS CULTIVATED)

Treatment	Rate/acre pounds	Price/pound cents	Yield/acre[a] pounds	Value/acre[a] dollars
Cultivation	-	.64	2821	1810
EPTC pre-transplant incorporated	3	.64	2750	1756
Trifluralin pre-transplant incorporated	1	.64	2741	1761
Trifluralin + diphenamid pre-transplant incorporated	1 + 3	.64	2716	1731
Diphenamid post-transplant	6	.64	2693	1732
Trifluralin + diphenamid pre-transplant incorporated	1/2 + 3	.64	2689	1716
Trifluralin + diphenamid pre-transplant incorporated	3/4 + 3	.63	2584	1639
Diphenamid post-transplant one shallow cultivation	6	.63	2540	1597

[a]Yield and value means are not significantly different at the 0.10 level of probability.

injury at greater rates. However, it exhibited no effective weed control properties in the herbicide only test.

Tobacco has previously proven to be quite tolerant of diphenamid. When applied at the rate of 6 pounds per acre with one shallow cultivation, there was no significant difference between the yield and value of this treatment as compared to a cultivated check receiving no herbicides.

The climatic conditions of this location had a direct influence upon the effectiveness of these herbicides (Appendix A). The effectiveness of these herbicides is greatly enhanced by rainfall. Precipitation for the month of June was 2.80 inches less than the thirty year mean of 3.88 inches. The July rainfall was 1.27 inches short of a mean of 5.13 inches for a thirty year average for July.

Spring Hill

The diphenamid plus one cultivation compared favorably with the cultivation only treatments (Figure 3) which were consistently higher in yield and value than any herbicide treated plot. This treatment exhibited the most promise, but reduced dollar per acre returns of $97 from conventional cultivation were obtained.

Diphenamid without cultivation failed to control weeds (Table 3) and tobacco yield and value were the lowest in this test (Table 4).

The EPTC treated plots were found to be significantly lower in value and pounds per acre than the cultivation plots. The EPTC treated plots yielded an average of 1598 pounds of burley per acre and an aver-

Figure 3. Diphenamid applied post-transplant to burley tobacco at the rate of 6 pounds per acre with one cultivation at the Middle Tennessee Experiment Station, 1964. Average weed control rating of 7.2.

TABLE 3

AVERAGE WEED CONTROL RATINGS FOR BURLEY TOBACCO RECEIVING VARIOUS TREATMENTS, SPRING HILL, TENNESSEE, 1964

Treatment	Rate - lb/A of active ingredient	Ratings[a] 8-1-64	8-27-64
Cultivation	-	7.5	8.0
Diphenamid post-transplant one cultivation	6	7.3	7.0
Trifluralin + diphenamid pre-transplant incorporated	1 + 3	6.0	6.8
Trifluralin + diphenamid pre-transplant incorporated	3/4 + 3	6.3	6.3
Trifluralin pre-transplant incorporated	1	4.6	4.5
Trifluralin + diphenamid pre-transplant incorporated	1/2 + 3	4.0	3.7
EPTC pre-transplant incorporated	3	4.0	3.7
Diphenamid post-transplant	6	3.3	1.7

[a]A rating of 0 indicates no weed control--a rating of 10 indicates complete weed control.

TABLE 4

AVERAGE PRICE, YIELD AND VALUE PER ACRE OF BURLEY TOBACCO RECEIVING VARIOUS TREATMENTS, SPRING HILL, TENNESSEE, 1964

Treatment	Rate/acre pounds	Price/pound cents	Yield/acre[a] pounds	Value/acre[a] dollars
Cultivation	-	.53	2205a	1186a
Diphenamid post-transplant one cultivation	6	.52	2071a	1189ab
Trifluralin + diphenamid pre-transplant incorporated	3/4 + 3	.52	1933a	1007 bc
Trifluralin + diphenamid pre-transplant incorporated	1 + 3	.51	1654 bc	852 cd
Trifluralin + diphenamid pre-transplant incorporated	1/2 + 3	.53	1645 bc	880 cd
Trifluralin pre-transplant incorporated	1	.51	1645 bc	838 cd
EPTC pre-transplant incorporated	3	.53	1598 c	849 cd
Diphenamid post-transplant	6	.53	1435 c	701 d

[a]Analysis of data by Duncan Multiple Range; mean followed by letter "a" is significantly different at 0.10 level of probability from means not followed by "a".

age return of $849 per acre compared with 2,205 pounds or $1,186 per acre for the cultivated tobacco. Figure 4 shows the poor weed control of EPTC under conditions such as they were for the 1964 season.

Trifluralin when applied at the 1 pound per acre rate resulted in poor weed control and in significantly lower yields and value when compared to conventionally cultivated plots.

The treatments receiving combinations of trifluralin and diphenamid were moderate as weed control herbicides in this test. Value per acre returns were from $175 to $360 lower than the conventionally cultivated treatments.

The 1964 season at Spring Hill seemed to be more favorable to good herbicide weed control with herbicides than the other locations. Evidence of some weed control was more prominent as is shown in Table 3.

A deficit of 2.27 inches of rainfall existed for the month of June at Spring Hill, but for July there was an excess of 0.65 inches of precipitation from a thirty year mean for this location (Appendix B).

Springfield

A comparison of weed control ratings for treatments in Table 5 show that only cultivation and the diphenamid plus one cultivation treatments gave satisfactory weed control. Figure 5 shows fire-cured tobacco that is practically weed free. This plot was treated with diphenamid and one shallow cultivation. The yield per acre and the value per acre of this treatment are not significantly different from the conventionally cultivated plots (Table 6).

Figure 4. EPTC applied pre-transplant incorporated to burley tobacco at the rate of 3 pounds per acre at the Middle Tennessee Experiment Station, 1964. Average weed control rating of 3.8.

TABLE 5

AVERAGE WEED CONTROL RATINGS FOR DARK FIRE-CURED TOBACCO RECEIVING VARIOUS TREATMENTS, SPRINGFIELD, TENNESSEE, 1964

Treatment	Rate - lb/A of active ingredient	Ratings[a] 8-1-64	8-27-64
Cultivation	-	10.0	10.0
Diphenamid post-transplant one cultivation	6	9.8	9.5
Diphenamid post-transplant	6	3.5	0.5
EPTC pre-transplant incorporated	3	3.3	0.0
Diphenamid post-transplant band applied	3	3.0	0.3
Trifluralin + diphenamid pre-transplant incorporated	1+3	2.5	0.8
Trifluralin + diphenamid pre-transplant incorporated	1/2+3	1.8	0.0
Trifluralin + diphenamid pre-transplant incorporated	3/4+3	1.5	0.0
Trifluralin pre-transplant incorporated	1	1.3	0.0

[a]A rating of 0 indicates no weed control--a rating of 10 indicates complete weed control.

Figure 5. Diphenamid applied post-transplant to dark fire-cured tobacco at a rate of 6 pounds per acre with one shallow cultivation at the Highland Rim Experiment Station, 1964. Average weed control rating of 9.7.

TABLE 6

AVERAGE PRICE, YIELD AND VALUE PER ACRE OF DARK FIRE-CURED TOBACCO RECEIVING VARIOUS TREATMENTS, SPRINGFIELD, TENNESSEE, 1964

Treatment	Rate/acre pounds	Price/pound cents	Yield/acre[a] pounds	Value/acre[a] dollars
Cultivation	-	.41	2571a	1119a
Diphenamid post-transplant one cultivation	6	.39	2663a	1065a
Diphenamid post-transplant band applied	3	.40	2134 b	859 b
Trifluralin + diphenamid pre-transplant incorporated	1 + 3	.40	1982 b	786 b

[a]Analysis of data by Duncans Multiple Range; mean followed by letter "a" is significantly different at 0.10 level of probability from means not followed by "a".

The application of diphenamid at the 6 pounds per acre rate without cultivation showed little promise and was associated with significantly lower yields and value. Similarly, returns from plots treated with 3 pounds per acre band application of the material on fire-cured tobacco showed little or no promise during the 1964 season.

Other treatments at this location showed little promise and $260 to $333 loss per acre were produced under the conditions of this experiment (Table 6). The remainder of the plots were severely infected with crabgrass (*Digitaria sanguinalis*), green foxtail (*Setaria vividis*), yellow foxtail (*Setaria lutescens*), and common ragweed (*Ambrosia artemisiifolia*).

Rainfall at Springfield was 2.53 inches short of the thirty year mean for June and during July there was a deficit of 1.50 inches of precipitation (Appendix C).

CHAPTER V

SUMMARY AND CONCLUSIONS

The primary objectives of this study using weed control practices were to determine:

1) By visual ratings the relative effectiveness of three selected herbicides upon the growth of weeds in tobacco;

2) The effects of herbicides upon the yield and quality of tobacco; and

3) The most effective of the herbicides tested for use in the production of burley and dark fire-cured tobacco.

The 1964 treatments on tobacco were made using three different materials: trifluralin, diphenamid, and EPTC. There were three treatments using a combination of trifluralin at one-half pound per acre, three-fourths pound per acre, and 1 pound per acre and diphenamid at 3 pounds per acre. One treatment of diphenamid at 6 pounds per acre with cultivation was applied to determine the effectiveness of such applications and treatments. Each of the three materials was also applied alone: EPTC at 3, diphenamid at 6, and trifluralin at 1 pound per acre.

In one test at Greeneville, all herbicide treated plots were cultivated to maintain 100 per cent mechanical weed control to determine if herbicide applications had any effect upon tobacco yield and quality if weeds were controlled.

The general effects of the herbicides on weeds and tobacco were evaluated by visual ratings to give some indication of the degree of weed control and the amount of injury sustained by the corp. Treatments that received ratings indicating effective weed control were harvested for yield and quality determinations. The treatments not receiving ratings indicative of good weed control were not harvested. From this one year study the following conclusions were drawn.

Diphenamid plus one shallow cultivation gave the most satisfactory weed control at all locations. This treatment, in terms of pounds per acre and dollars received per acre, was not significantly different from the returns from the cultivated check when subjected to Duncan's Multiple Range Test at the 0.10 level of probability.

At the Greeneville location, where all the treatments were cultivated, a non-significant difference of yield and of value between the herbicide-cultivated plots and the cultivation only plots was noted. This indicates that herbicides had no adverse effect upon the yield and quality of burley tobacco under the prevalent conditions.

The ineffectiveness of these herbicides in the absence of cultivation, especially at the Greeneville location, to control weeds may possibly be attributed to the absence of precipitation during the first few weeks after herbicides were applied (Appendix A). Indications are that rainfall is extremely important to the effectiveness of these herbicides.

Trifluralin and diphenamid applied separately or in combination resulted in poor weed control, a reduced yield and dollar return per acre. Evidently the loss was due to the competition of weeds and tobacco for plant nutrients and moisture. Injury of the tobacco by the herbicide, as reported previously, was not noted during the 1964 season.

EPTC treatments in absence of cultivation did not control weeds and reduced yield and value of the tobacco. This material continued to give erratic results as during the 1963 tobacco season.

Each of the chemicals used in this experiment were ineffective weed control agents except when cultivations were also applied. A general conclusion that it will pay farmers of Tennessee to continue use of good conventional cultivation practices can be drawn from this study.

It is possible that cultivation may be beneficial for reasons other than weed control. Though some investigators (7) have concluded that cultivation is important for weed control only, this may not be necessarily true in some soils of Tennessee where crusts form quite readily due to the physical properties of soils and the intensity of rainfall. For example, studies of root aeration by Kramer (25), Harris and Van Bavel (15, 16) indicate that poor soil or root aeration can adversely affect plant growth in such an event.

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APPENDIXES

APPENDIX A

RAINFALL DATA 1964, TOBACCO EXPERIMENT STATION (37)

Day	May	June	July	Aug.	Sept.
1		.33	.23		
2		.02			
3	.31				
4			.06	1.03	
5					
6					
7				.04	
8			.38		
9			.80		
10					
11	.25			.05	
12	.57		.77	.11	
13	.07	.19	.12		
14					
15		.52		.09	
16		.02		1.69	
17				.05	
18				.22	
19			.27	.24	1.70
20					.26
21			.06		
22					
23					.23
24	.03				
25			1.10		
26			T*		
27	.07			.03	
28	.18				.02
29	.21		.03	.01	.84
30				2.05	.44
31				.30	
Total	1.69	1.08	3.82	5.91	3.49
30 year mean	3.60	3.88	5.13	4.02	2.56

*T Trace (Amount too small to record)

APPENDIX B

RAINFALL DATA 1964, MIDDLE TENNESSEE
EXPERIMENT STATION (37)

Day	May	June	July	Aug.	Sept.
1		1.20			
2	2.70		.09		
3	.08				
4			.70		
5					
6			.10		
7			.31		
8				.15	
9				.08	
10	.05				
11	.16				
12	.15		1.78		
13			.03		
14					
15				3.14	
16				1.16	
17		.02			
18		.11			.44
19			.50		
20			.69		
21					
22					
23					
24					
25			.20	.51	
26				.67	
27			.05	.04	
28	.19				1.21
29	.01				.62
30			.05		
31	.23				
Total	3.57	1.33	4.50	5.75	2.27
30 year mean	3.81	3.50	3.85	3.72	2.77

APPENDIX C

RAINFALL DATA 1964, HIGHLAND RIM EXPERIMENT STATION (37)

Day	May	June	July	Aug.	Sept.
1		.24	.06		
2			.02		
3	.07				
4			.50		
5					
6					
7			T		
8			T	.47	
9			.34		
10					
11	.04	T	.14		
12	.46		.08	.68	
13		.02	.25		
14	.01				
15				T	
16		.37		1.16	
17				.01	
18		T	T		.68
19			.05	.55	.36
20			.26		
21					
22				.21	
23	T*		.01	.16	.02
24	T	.03			
25	.33				
26			.20	1.13	
27	.15			T	
28	.53				1.00
29	.21				1.00
30		.06	.31		.02
31					
Total	1.80	.72	2.22	4.37	3.08
30 year mean	3.72	3.25	3.72	2.86	2.87

*T Trace (Amount to small to record)