ricultural Experiment Station
technic Institute and State University

Bulletin 84-6
ISSN 0096-6088

An Evaluation of No-Tillage Culture for Burley Tobacco

Le ik

James R. Nichols, Dean and Director
College of Agriculture and Life Sciences
Virginia Agricultural Experiment Station
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

The Virginia Agricultural and Mechanical College came into being in 1872 upon acceptance by the Commonwealth of the provisions of the Morrill Act of 1862 "to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." Research and investigations were first authorized at Virginia's land-grant college when the Virginia Agricultural Experiment Station was established by the Virginia General Assembly in 1886.

The Virginia Agricultural Experiment Station received its first allotment upon passage of the Hatch Act by the United States Congress in 1887. Other related Acts followed, and all were consolidated in 1955 under the Amended Hatch Act which states "It shall be the object and duty of the State agricultural experiment stations . . . to conduct original and other researches, investigations and experiments bearing directly on and contributing to the establishment and maintenance of a permanent and effective agricultural industry of the United States, including the researches basic to the problems of agriculture and its broadest aspects and such investigations as have for their purpose the development and improvement of the rural home and rural life and the maximum contributions by agriculture to the welfare of the consumer . . . "

In 1962, Congress passed the McIntire-Stennis Cooperative Forestry Research Act to encourage and assist the states in carrying on a program of forestry research, including reforestation, land management, watershed management, rangeland management, wildlife habitat improvement, outdoor recreation, harvesting and marketing of forest products, and "such other studies as may be necessary to obtain the fullest and most effective use of forest resources."

In 1966, the Virginia General Assembly "established within the Virginia Polytechnic Institute a division to be known as the Research Division . . . which shall encompass the now existing Virginia Agricultural Experiment Station . . . "

AN EVALUATION OF NO-TILLAGE CULTURE FOR BURLEY TOBACCO

Leo A. Link

Southern Piedmont Research Center

and

Department of Agronomy

College of Agriculture & Life Sciences
Virginia Agricultural Experiment Station
Virginia Polytechnic Institute
and State University
Blacksburg, Virginia 24061

Bulletin 84-6

ABSTRACT

The no-tillage system of tobacco production was evaluated by planting the Ky 14 variety of burley in sod or mulch covers killed by paraquat or glyphosate. Diphenamid, benefin, oryzalin, and chlorbromuron were tested as herbicides to control annual grasses and broadleaf weeds.

Glyphosate was more effective than paraquat in killing existing vegetation, especially when perennials were present. There was danger of injury to the tobacco if contact was made with herbage treated with either glyphosate or paraquat. Diphenamid, benefin, oryzalin, and chlorbromuron caused little or no injury to the tobacco, and all four gave adequate control of annual grasses and broadleaf weeds.

There was a trend toward brighter colored and thinner tobacco with the no-tillage system, but yields averaged 14% less than with the conventional system.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The no-tillage system has been used successfully for the production of field crops, particularly corn and soybeans, for several years. In this system a sod or mulch cover crop is killed with herbicides and the crop planted with the least soil disturbance possible. Herbicides also are used to control annual weeds during the growing season. The no-tillage system permits crops to be grown on slopes normally subject to erosion when cultivated, and has been reported to conserve soil moisture by reducing runoff (2). Studies have shown that tobacco benefits from cultivation even in the absence of weed competition; however, in those studies the land was prepared in the conventional manner for planting rather than for no-tillage planting (1). No-tillage tobacco studies by Moschler et al. (5), using paraquat to kill a fescue sod, showed yields of burley tobacco to be 7.8% lower and of flue-cured tobacco, 9.3% lower than with the conventional system. The principal effect of the no-tillage system was a tendency to produce higher percentages of thin tobacco. Research was conducted at the Southwest Virginia Research Station in 1972 to 1977 and 1980 to evaluate the use of certain herbicides, mulch covers, and timing of herbicide applications for the production of no-tillage burley tobacco.

MATERIALS AND METHODS

Herbicides and mulch covers varied from year to year as new treatments were evaluated, but the following general procedures were used for each test. Fertilizer at the acre rate of 175 lbs N, 200 lbs P_2O_5, and 300 lbs K_2O was broadcast on all plots on the same date and then disked in on the conventional culture plots but left on the surface of no-tillage plots. Test design was a randomized block of four replications with individual plots 4 rows wide and 33 feet long with a 42-inch row spacing and a 20-inch spacing between plants within the row. Applications of liquid herbicides were made with a back pack sprayer equipped with a double swivel OC-04 TeeJet[1] nozzle. Granular herbicides were spread by hand. The Ky 14 variety of tobacco was transplanted in the no-tillage plots with a Holland transplanter, modified for no-tillage planting (4), and in the conventional culture plots with a standard Holland transplanter. Unless specified in individual tests, missing plants were not replanted. Initial stands were good, with 92% to 96% of the plants surviving. Mature tobacco was harvested from the two center rows of each plot and cured. Following curing, the tobacco was separated into 4 grades, weighed to calculate yields, and graded by an inspector from the U. S. Department of Agriculture Tobacco Inspection Service.

While market price is often used as a measure of quality, market price depends partly on the supply situation and may not represent

---

[1] Spraying Systems Co., Wheaton, Ill.

a true evaluation of the quality of the tobacco. In this study quality refers to the grade placed on the tobacco by the federal inspector. In the tables, the percentage of tobacco from each treatment by weight in the top three quality grades (1,2,3) was separated on the basis of 1 = choice, 2 = fine, 3 = good, 4 = fair, and 5 = low. The percent of thin-bodied tobacco graded as flyings (X) and lugs (C) was listed as the X & C group. Tobacco color grades other than L, F, FR, or R were classified as off color.

Glyphosate (Roundup) and paraquat with the surfacant multifilm X-77 at .065% (v/v) were evaluated to kill existing vegetation. Herbicides to control annual grasses and broadleaf weeds were diphenamid (Enide) as 50% wettable powder, benefin (Balan) as 2.5% granules, oryzalin (Surflan) as 75% wettable powder, and chlorbromuron (Maloran) as 50% wettable powder.

1972. Paraquat and glyphosate at various rates with diphenamid (4.5 lbs ai/A) were sprayed on a four-year-old stand of orchardgrass at the heading stage (18 to 20 inches tall). Treatments were applied May 11 using 35 gallons of water per acre. Initial kill of orchardgrass varied from 79% with paraquat to 96% with the high rate of glyphosate. Tobacco was transplanted June 6. A directed spray of paraquat at 1.0 lb ai/A was used on July 10 in all plots to kill the orchardgrass which was not killed by the original spraying. There was some activity by cutworms and minor damage from slugs but stands were considered satisfactory. A cultivated check was not used.

TABLE 1. Effect of herbicide treatments on the yield and quality of burley tobacco grown in orchardgrass sod in 1972

Treatment[1/]	Rate lb ai/A	Yield lbs/A	Percent by weight Quality 1,2,3	X & C group	Off color
Paraquat	1.0	2213	84	40	0
Glyphosate	1.0	1992	81	50	0
Glyphosate	2.0	2323	81	44	0
Glyphosate	3.0	2160	83	49	0
L.S.D. (.05)		NS	NS	NS	NS

[1/] Each treatment received diphenamid at 4.5 lb ai/A.

1973. Glyphosate at 2 lbs ai/A in 30 gallons of water was applied to a three-year-old orchardgrass sod (fully headed) on May 21. Herbicides for residual weed control were applied the same day as the glyphosate but as a separate application. Tobacco was transplanted June 14. A poor kill of the orchardgrass was achieved and may have been influenced by rainfall of 0.9 inch recorded within 24 hours after treatment. A directed spray of paraquat at 1 lb ai/A was used on July 10 to control the orchardgrass. Control of annual weeds was satisfactory, but herbicides were not rated because of the influence of the late treatment with paraquat.

TABLE 2. Effect of no-tillage treatments on the yield and quality of burley tobacco grown in an orchardgrass sod in 1973

Treatment[1/]	Rate lb ai/A	Yield lbs/A	Percent by weight: Quality 1,2,3	X & C group	Off color
Benefin	3.0	2166	75	51	19
Oryzalin	2.0	2169	71	49	19
Chlorbromuron	3.0	2153	82	52	14
Cultivated check	-	2162	78	51	13
L.S.D. (.05)		NS	NS	NS	NS

[1/] Each herbicide treatment also received glyphosate at 2 lbs ai/A before planting and paraquat at 1 lb ai/A as a directed spray on July 10.

1974. The test was conducted on an area seeded to rye following a 1973 tobacco crop and on an area of five-year-old orchardgrass sod. The cultivated check plots were prepared in the orchardgrass area only. Initial application of glyphosate at 2 lbs ai/A was made on May 14 in a volume of 40 gallons of water per acre. The rye averaged 60 inches tall and headed; the orchardgrass was 18 inches tall and heading. Treatments for the control of annual weed growth were applied May 28, at which time additional glyphosate at 1 lb ai/A was applied to kill any subsequent new growth and to kill any orchardgrass or rye missed by the initial treatment. Tobacco was transplanted on all plots on May 30.

TABLE 3. Effect of no-tillage treatments on the yield and quality of burley tobacco grown in 1974

Treatment[1/]	Rate lb ai/A	Yield lbs/A	Percent by weight: Quality 1,2,3	X & C group	Off color
Orchardgrass mulch					
Benefin	3.0	3346	71	44	35
Oryzalin	2.0	3133	76	30	24
Chlorbromuron	3.0	3155	47	34	41
Rye mulch					
Benefin	3.0	2598	78	50	0
Oryzalin	2.0	2496	81	32	5
Chlorbromuron	3.0	2451	82	31	0
Cultivated check	-	3031	77	28	13
L.S.D. (.05)		326	18	21	16

1/ All treatments except the cultivated check received glyphosate at 2 lbs ai/A on May 14 and 1 lb ai/A on May 28.

1975. The test of no-tillage treatments was conducted with two replications in an area seeded to rye following tobacco in 1974 and in a five-year-old orchardgrass sod. The cultivated check was replicated twice in each area on land plowed March 27. A tank mix of glyphosate with the chemicals used for annual weed control was applied May 21 on no-tillage plots, except that benefin granules were applied separately by hand. All spray applications were applied in 100 gallons of water per acre. The rye was fully headed, with an average height of 63 inches, and the orchardgrass was in full bloom, with an average height of 34 inches. The initial kill by glyphosate of the rye was 99% and of the orchardgrass 96%. Tobacco was transplanted June 5.

TABLE 4. Effect of no-tillage treatments on the yield and quality of burley tobacco grown in 1975

Treatment[1/]	Rate lb ai/A	Yield lbs/A	Percent by weight Quality 1,2,3	X & C group	Off color
Orchardgrass mulch					
Benefin	3.0	2172	61	44	0
Oryzalin	2.0	2056	23	45	0
Chlorbromuron	3.0	1844	12	42	0
Rye mulch					
Benefin	3.0	2509	48	38	0
Oryzalin	2.0	2710	52	40	0
Chlorbromuron	3.0	2385	58	42	0
Cultivated check	-	2812	50	34	0
L.S.D. (.05)		313	22	NS	NS

[1/] Each herbicide treatment also received glyphosate at 2 lbs/A on May 21.

1976. The test was conducted with mulch covers of rye, barley, and ryegrass seeded the previous fall. Glyphosate at 2 lbs ai/A or paraquat at 2 lbs ai/A was used to kill the mulch covers. Oryzalin at 1.5 lbs ai/A was used on all plots as a tank mix to control annual weed growth. Treatments were applied in 40 gallons of water per acre on May 10. The rye was fully headed at 44 inches tall, the barley was headed at 23 inches, and the ryegrass was heading at 13 inches. The tobacco was transplanted on June 3. At this time there was almost a complete kill of the rye and barley by both the glyphosate and the paraquat but only a 96% kill of the ryegrass by the glyphosate and 85% by the paraquat. On June 28 it was noted that stands of tobacco

were poor, due principally to insect activity, mostly slugs; the ryegrass had made considerable regrowth and annual weeds were not being controlled on most plots. The test was abandoned and yields were not taken.

1977. Cover crops of barley, barley/vetch, and vetch were seeded September 24, 1976, to provide mulch for the no-tillage treatments in 1977. Barley also was seeded as a cover crop for the conventional tillage check treatment and plowed under April 22, 1977. Glyphosate at 2 lbs ai/A in 40 gallons of water was used to treat the cover crops on May 9. The barley was fully headed at 29 inches, and the vetch was variable in height to 15 inches. The severe winter of 1976-1977 caused some reduction in stands of both the barley and the vetch but there was full ground cover at the time of treatment. Additional glyphosate at 0.5 lb ai/A was sprayed on one-half of each no-tillage plot on June 3 to treat any subsequent weed growth or cover crops not killed by the earlier treatment and to check for residual effect of glyphosate when used closer to the time of transplanting tobacco. At this time essentially all the barley was dead and the vetch exhibited various stages of necrosis, but it appeared that several plants would recover. Tobacco was transplanted on June 7. Oryzalin at 1.5 lbs ai/A was broadcast uniformly on all plots including the cultivated check as a post-plant treatment to control annual weed growth. In addition to being treated with oryzalin, the check plot was also cultivated twice.

TABLE 5. Effect of no-tillage treatments on the yield and quality of burley tobacco grown in 1977

Treatment[1/]	Rate lb ai/A	Yield lbs/A	Percent by weight: Quality 1,2,3	X & C group	Off color
Glyphosate	2.0				
Barley		2177	35	44	96
Barley/vetch		1906	11	45	71
Vetch		1847	0	41	69
Glyphosate	2.0 + 0.5				
Barley		2080	46	42	87
Barley/vetch		1914	19	45	78
Vetch		1956	26	43	86
Cultivated check	-	2576	73	38	0
L.S.D. (.05)		308	42	NS	34

[1/] Oryzalin at 1.5 lbs ai/A was applied to all plots at a post-plant treatment on June 15.

1980. The test site had a cover crop of rye which had been seeded October 9, 1979. The cultivated check plots were plowed April 8, 1980. Various rates of glyphosate were evaluated for no-tillage culture of burley tobacco. Initial treatments were applied on May 5 in 40 gallons of water per acre when the rye was 35 inches tall and beginning to head. One treatment included a second application of glyphosate which was made on June 3, and the tobacco was transplanted on all plots on June 4. Diphenamid at 6 lbs ai/A in 20 gallons of water was applied uniformly to all plots, including the cultivated check, over the top on June 9 for residual weed control.

TABLE 6. Effect of no-tillage treatments on the vigor, stand, and yield of burley tobacco grown in a rye mulch in 1980

Treatment[1/]	Rate lb ai/A	7/3 Vigor rating[2/]	7/3 Tobacco % stand	Yield lbs/A
Glyphosate	3.0	8.2	82	1615
Glyphosate	2.0 + 1.0	8.0	84	1664
Glyphosate	6.0	6.4	74	1596
Glyphosate	12.0	4.5	62	1488
Cultivated check	-	9.5	96	2008
L.S.D. (.05)		1.6	8	296

1/ Diphenamid at 6 lbs ai/A was surface applied post-plant to all plots.
2/ Vigor rating: Scale 0 = all plants dead to 10 = best growth.

TABLE 7. Effect of mulch covers on soil temperatures at the 3-inch depth on a sunny day

Mulch cover	°F 6/18 1974	6/30 1975	6/11 1980
Orchardgrass	73	82	--
Rye	71	78	71
None - cultivated	78	87	77
Air temperature	80	90	79

TABLE 8. A comparison of the best and poorest no-tillage treatment with the cultivated check for the years indicated

Treatment	Yields in pounds per acre 1973	1974	1975	1977	1980	Avg.
No-tillage						
Best treatment	2169	3346	2710	2080	1664	2394
Poorest treatment	1990	2451	1844	1914	1488	1937
Avg. of no-tillage	2119	2863	2279	1983	1591	2167
Cultivated check	2162	3031	2812	2576	2008	2518

RESULTS AND DISCUSSION

An almost complete kill of the sod is necessary for successful no-tillage culture. Paraquat does not achieve this as well as glyphosate, particularly if perennials are involved. When a contact herbicide such as paraquat or glyphosate is used, a split application is usually needed because a canopy of heavy growth may protect some plants from receiving a lethal dose at the initial spraying. This appeared to be the situation even when a spray volume of 100 gallons per acre was used. The second application following an initial "knock down" serves to control any missed plants as well as subsequent growth of late-emerging plants.

The paraquat and glyphosate did not appear to be phytotoxic in the soil but appeared to cause phytotoxicity to tobacco coming into contact with the treated vegetation. The interval between treatment and transplanting did not appear to be important in this regard, as the 3 lb ai/A rate in one application 30 days before transplanting caused the same injury as when split with 1 lb ai/A applied the day before transplanting (Table 6). In the rate study in 1980, injury to the tobacco increased as the rate of glyphosate was increased, resulting in the death of some plants. In all of the tests there was no advantage in using rates higher than 3 lbs ai/A to kill existing vegetation. Small grains and many annuals can be killed with lower rates, but some perennials tend to recover. Also, it should be considered that temperatures and growing conditions at the time of treatment

usually are not the optimum for absorption of such contact herbicides.

The transplanter, as modified for sod planting, performed well in both the orchardgrass and the annuals used for mulch since essentially a full complement of plants was properly placed in all plots. In heavy mulch such as tall rye there was a tendency for the tractor wheel to push some mulch into contact with previously set plants in the adjoining row as it proceeded in the transplanting operation. This contact may smother the tobacco plant or at least cause a phytotoxic effect as the tobacco is contacted by the herbicide-treated mulch.

Tobacco in the no-tillage plots grew more slowly than that in the cultivated plots early in the season. This effect might be explained partially by the difference in soil temperature (Table 7). Later in the season, possibly because of more uniform moisture conditions and increased soil temperature as some of the mulch disintegrated, the tobacco in the no-tillage plots made more rapid growth, so that there was no apparent difference in the date of maturity between the methods of planting. No-tillage planting probably should be somewhat later than the time which is normal for conventional culture to allow the soil temperature under mulch cover to increase. Later planting permits application of the pre-plant herbicide to be made later in the season to achieve better kill of perennial plants.

Zartman et al. (6) found that there was a greater root density in the top 6 inches of the profile for conventional tillage than for no-tillage of burley tobacco, regardless of nitrogen level. They reported the no-tillage tobacco roots were restricted to the transplanting trench, limiting initial horizontal growth; but once the roots had

extended vertically beyond the trench, there was little difference in densities for the two tillage treatments.

In a comparison of no-tillage treatments with the cultivated check, there was an average reduction of 5% for the best treatment each year to 23% for the poorest, with an average of 14% for all no-tillage treatments (Table 8). With the no-tillage system, transplanting can be done when the soil moisture is much higher than with conventional culture. Brighter-colored lower leaves are obtained and the tobacco is easier to keep clean and free of soil during harvesting, particularly if staked out in the field and subjected to rain. The tobacco could be planted on sloping terrains, normally subject to erosion, but these soils generally are less favorable for tobacco production and thus using this land may not be an advantage.

In evaluating the no-tillage system, consideration also should be given to the erosion potential following the production of the principal crop. It has been shown that as much as 50% of the annual soil loss to erosion may occur during winter freezing and thawing of the soil when there is a small amount of surface residue with a conventionally-seeded small grain crop (3). If the method for establishing the succeeding crop following tobacco requires the land to be plowed, there may be no lessening of the potential for erosion with the no-tillage system. With no-tillage culture of tobacco, as with no-tillage production of other crops, greater efficiency of management is required if crop production is to be successful. This study indicates that success with no-tillage production of tobacco is less predictable than with the conventional system.

LITERATURE CITED

1. Hawks, S. N., Jr. and W. K. Collins. 1970. Effects of a herbicide and levels of cultivation on yield and value of flue-cured tobacco. Tob. Sci. 14:170-172.

2. Jones, J. N., Jr., J. E. Moody, and J. H. Lillard. 1969. Effects of tillage, no-tillage, and mulch on soil water and plant growth. Agron. J. 61:719-721.

3. McCool, D. K. 1984. Reducing erosion from thawing soil. Agric. Res. U. S. Dep. Agric. 32(5):7.

4. Morrison, J. E., Jr., J. H. Smiley, W. O. Atkinson, and D. C. Milbocker. 1973. A no-tillage transplanter. Tob. Sci. 17:44-46.

5. Moschler, W. W., G. M. Shear, M. J. Rogers, and T. R. Terrill. 1971. No-tillage tobacco studies in Virginia. Tob. Sci. 15:12-14.

6. Zartman, R. E., R. E. Philips, and W. O. Atkinson. 1976. Tillage and nitrogen influence on root densities and yield of burley tobacco. Tob. Sci. 20:136-139.

Virginia's Agricultural Experiment Stations

1—Blacksburg
Virginia Tech

2—Steeles Tavern
Shenandoah Valley Research Station

3—Orange
Piedmont Research Station

4—Winchester
Winchester Fruit Research Laboratory

5—Middleburg
Virginia Forage Research Station

6—Warsaw
Eastern Virginia Research Station

7—Suffolk
Tidewater Research and Continuing Education Center

8—Blackstone
Southern Piedmont Research and Continuing Education Center

9—Critz
Reynolds Homestead Research Center

10—Glade Spring
Southwest Virginia Research Station

11—Hampton
Seafood Processing Research and Extension Unit