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CONCLUSIONS

Studies over a 3-year period indicate that the use of a black petroleum resin mulch consistently increases soil temperatures in the zone of seed germination and emergence. The improvement in environment for seed germination and early seedling growth contributed to the significant improvement in plant stands obtained from this treatment.

Studies conducted in 1963 indicated that with mulch bands 6 inches wide, the soil temperature was maximum with a 25-gallon-per-acre application rate. Narrower bands, regardless of rate, were less effective. In 1963 significant increases in yields were obtained only from a 6-inch band application of mulch.

One of the most serious problems encountered in working with the petroleum mulch was obtaining effective weed control under the mulched area. Of the different herbicides evaluated, only a soil-incorporated application of trifluralin gave effective weed control in the mulch bands.

In plantings with widely spaced hills, mulch rates may be reduced by using spot application techniques. A 9-gallon-per-acre rate, applied in 9-inch square spots over each hill, was effective in improving stands.

Mulch treatments were quite effective in reducing soil crusting following rains in the 1964 test.

In general, the use of a petroleum mulch seems to be a desirable practice. On the basis of 10 cents per pound for seed cotton, an increase of $77.40 was obtained from the best mulch treatment in the 1963 study. This is high return for material and equipment cost.

However, experience with handling, transfer, and application of this type of mulch is necessary to establish its value as a farm production practice. The viscous nature of the product means that transfer from shipping containers to application equipment is slow. Consequently, use of the mulch with the planting unit would slow down the planting operation considerably. Use of separate application equipment would increase the need for labor during the critical planting period.

In other published reports[3,4], where mulch was used, yields were increased only in very early plantings. With petroleum mulch costs of at least $8.50 per acre, for the 25-gallon-per-acre rate, yield increases would need to be considerable to warrant general use. In areas where early planting is necessary, or where crusting problems are of frequent occurrence, the use of mulch could be economically feasible.

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[3]Cochran, B. J., L. H. Wilkes, G. A. Niles, D. I. Dudley, and T. L. Thaxton. 1964. The effects of a petroleum mulch on the growth and development of cotton. Texas A. Exp. Sta Progress Report 2312.

[4]Phillips, R. E. and R. E. Frans. 1965. Effect of petroleum mulch on growth and yield of cotton in eastern Arkansas. Ark. Ag. Exp. Sta Bull. 699. 21 pp.

EFFECTS OF PETROLEUM MULCH ON GROWTH AND YIELD OF COTTON

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Mulches of various types have for many years been used in the production of high-income crops. While the benefits obtained from such treatments are desirable in cotton production, problems of application and cost of materials often exceed return. In 1962 the Humble Oil and Refining Company made available a specially formulated water emulsion formulation of petroleum resins[2] that could be sprayed on the soil to form a black mulch film.

Studies were initiated in 1962 at the Delta Branch Experiment Station to evaluate this material as a means of reducing seedling disease, and of increasing cotton growth, development and yield.

1962 Tests

The test was planted on April 19, in a randomized block design with six replications. The mulch was applied as a spray in a 6-inch band over the seed drill during the normal planting process by using a conventional bronze gear pump spray system. A single rate of 100 gallons per acre of mulch was applied in 6" bands using a single 65 degree fan nozzle, with an orifice capacity of 1.5 gallons per minute per row. Several planter-box fungicides were used with the mulch treatment in an effort to reduce seedling disease losses. A preemergence herbicide, 3-(3,4-dichlorophenyl) - 1, 1-dimethylurea (diuron) was applied immediately ahead of and placed underneath the petroleum mulch.

Soil temperatures were measured by thermometers placed 2 inches under the surface of the seedbed. Yield data were obtained as a single harvest using a spindle-type picker.

Results and Discussion, 1962: The mulch treatment alone was as effective as a planter-box fungicide in reducing stand losses (Table 1). With high soil temperatures in early May, PCNB alone (and also with the mulch treatment) was toxic to the developing cotton. This accounts in part for the low stands associated with the 15% PCNB fungicide treatment.

The rate of mulch used in this study is neither economically nor mechanically feasible for cotton production. But results obtained, and observations made on the stability of the mulch band, suggested that similar benefits might be obtained with lower mulch rates. The mulch treatment promoted weed growth. The diuron herbicide treatment gave excellent control of weeds on either side of the mulch band, but did not control weeds adequately in the band of soil covered by the mulch.

Readings at 9 a. m., 2 and 5 p. m. indicated that plantings receiving the

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[2]Trade name ENCAP. Trade names are used in this publication solely to provide specific information. Mention of a trade name does not constitute endorsement by the U. S. Department of Agriculture or the U. S. Department of Commerce over other products of a similar nature not mentioned.

mulch treatment had soil temperatures 2° to 6° F. higher (at the 2-inch level) than the check plots.

1963 Tests

The 1963 test was planted on April 12, or approximately 2 weeks before normal for this area. The study was made to determine the effect of rate of application and band width of mulch on the emergence, final stand, uniformity of stand, and yield of cotton. Mulch rates and band widths were varied to give similar film densities. The mulch rates ranged from 8.5 to 100 gallons per acre banded on 40-inch rows. A conventional bronze gear pump was used to spray the mulch solution. Fan-pattern nozzles with a 65° spray angle were used. The 100-gallon rate used an orifice capacity of 1.5 gallons per minute and the 8.5 gallon rate used an orifice capacity of .15 gallons per minute. Planting speed was 2.5 mph.

A multichannel temperature recorder was used to measure temperatures. As the capacity of the recorder was limited to 7 readings, only temperatures under the mid - range of mulch rates were measured. A preemergence herbicide treatment, diuron, was applied immediately ahead of and therefore underneath the mulch treatments. A randomized block design with six replications was used in this study.

Results and Discussion, 1963: All mulch treatments gave plant populations significantly higher than the check plantings (Table 2). However, no greater uni-

Table 1. Summary of study evaluating effects of petroleum mulch and 3 pounds per acre applications of several planter-box applied fungicides on stand and yield of cotton, 1962.

Treatment		Plants per acre[1]	Missing hills per acre[1]	Yield per acre, lbs. seed cotton[2]
Mulch	Fungicide			
100 gals.	None	50,324**	464**	2,553
100 gals.	Maneb + (10 + 10%)	47,500*	289**	2,372
100 gals.	Captan + PCNB (10 + 10%)	45,918	374**	2,502
None	Maneb + PCNB (10 + 10%)	44,376	374**	2,482
None	Captan + PCNB (10 + 10%)	43,098	499**	2,392
None	None	41,926	1,078	2,452
None	PCNB (15%)	39,596	539**	2,342
100 gals.	PCNB (15%)	39,471	873	2,181

[1]Asterisks denote treatments significantly better than the untreated check, single asterisk indicates significance at the 5% level, double asterisks indicate significance at the 1% level as measured by Duncan's New Multiple Range Test.

[2]Differences are not significant.

Table 2. Summary of study evaluating different petroleum mulch rates and band widths on stand and yield of cotton, 1963.

Treatment		Stand, plants/A			Hills/A[1]			Yield, lbs. seed cotton/A[2]
Gals. mulch	Band width	4/27	5/4[2]	5/18[2]	4/27[2]	5/4	5/18	
0	...	15,665	16,662	19,529	5,693	5,693	6,316	2,750
100	6"	13,421	19,446*	24,142*	4,737*	6,524	6,399	3,447*
67	4"	18,408	23,061*	27,258*	5,983	6,607	6,814	3,062
50	6"	15,250	20,693*	27,715*	5,526	6,607	6,939	3,338*
33	4"	15,873	19,155*	24,931*	5,693	6,233	6,690	3,090
25	6"	16,995	20,070*	26,718*	5,236	6,316	6,981	3,524*
17	4"	14,876	18,158	24,516*	5,983	6,441	6,898	3,151
12.5	6"	12,216	17,369	22,480*	4,778*	6,067	6,607	2,950
8.5	4"	18,158	17,660	22,687*	5,734	5,942	6,399	3,062

[1]Perfect stand would be 7,665 hills.

[2]Asterisks denote treatments significantly different from the untreated check at the .05 level as measured by Duncan's New Multiple Range Test.

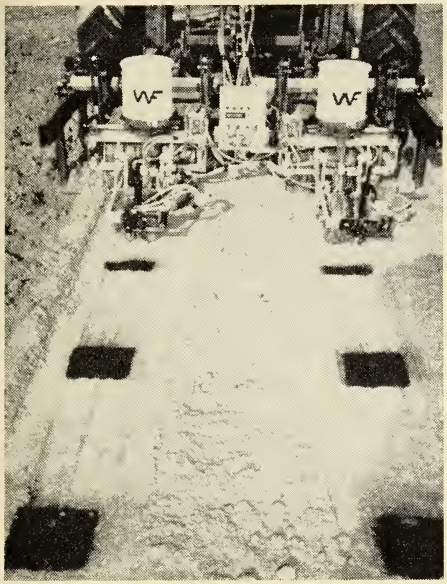

Figure 1. Research planter using cam-operated switches to synchronize hill-drop placement of seed and spot application of a petroleum mulch.

formity of stand, as measured by hills per acre, was obtained from any of the mulch treatments. Stand evaluations showed little difference among the various mulch treatments, either in gallons per acre or band width. When yield is considered, striking differences become apparent. Band width was a major factor in yield response. A 6-inch band resulted in yield increases that were not present with the narrow 4-inch band. Yield data, as well as all the stand data, indicate that as much benefit was obtained from 25 gallons per acre as from any of the higher rates.

Temperature data were evaluated for an 8-day period from April 16-23, 1963. Except for cloudy skies and .10 inch of rain during one day, weather conditions were generally clear to partly cloudy, with moderate winds. A summary of the effect of mulch rates on soil temperature is presented in Figure 2. The relative high temperature recorded under the 50-gallon-per-acre rate was undoubtedly due to the slope of the seedbed surface. Rows were orientated east to west; and because of a damaged planter presswheel, a slight southerly slope, about 25° downward for three-fourths of an inch, was formed over the seed drill. Although this may seem to be a slight deviation from the flat seedbed in the other treatments, the slight "profile" exposed to the sun resulted in daytime soil temperatures 2 to 3° F. higher than in any other mulch treatment. Damage to the planter presswheel was corrected after one replication (that in which temperature readings were made) of the 50 gallon-per-acre rate was planted.

Application of 17 gallons of mulch on a 4-inch band and 25 gallons on a 6-inch band resulted in mulch films of equal density. Hence, difference in response should be due to band width alone, A study of the data for the 25-gallon rate versus the 17-gallon rate shows a slight (but not significant) benefit in stand for the 25-gallon rate. In yield and temperature the differences are much greater. The advantages of a wider band of equal density are apparent in the yield data, and to a lesser but definite extent in the temperature data. The 12.5 - gallon rate on a 6-inch band resulted in higher soil temperatures than the more dense 17-gallon rate on a 4-inch band. The temperature data presented are for daylight hours only. The cooling rate at night was the same for all treatments and variations in minimum temperature were slight.

The use of a preemergence herbicide treatment with diuron failed to give adequate weed control in the portion of row covered with the petroleum mulch.

1964 Tests

The 1964 test was planted on April 17 in a randomized block design with five replications. An effort to reduce

mulch costs and to achieve effective weed control seemed desirable to determine the feasibility of using petroleum mulch in cotton production. A study using two different mulch patterns and rates, combined with three different herbicide treatments, was made in 1964. The different mulching patterns (one was a 6-inch wide continuous band, and the other was a 9-inch square spot centered over hills 36 inches apart) required 25 and 9 gallons of mulch per acre respectively.

A research planter was designed to synchronize a sprayed spot of mulch over the hill-planted cottonseed, figure 1. Electrical switches, which were actuated by single-lobe cams, controlled a compressed air system. Miniature air cylinders operated the planter hill-drop valve and a quick opening valve mounted in the discharge line of each mulch spray nozzle. Cam lengths and placement controlled the opening of the hill-drop valve and the length and spacing of the sprayed spots. The nozzle valve was placed in the open position to apply the continuous band treatments.

These two methods gave mulch films of equal density but with different areas and continuity. A planter-box fungicide treatment, 3 pounds per acre of 10% PCNB-10% captan, was used in all plantings. Preemergence herbicide treatments of 2,4-bis(isopropylamino)-6-methylmercapto-s-triazine (prometryne) and a,a,a-trifluro-2,6-dinitro- N, N -dipropylp-p-tolui-

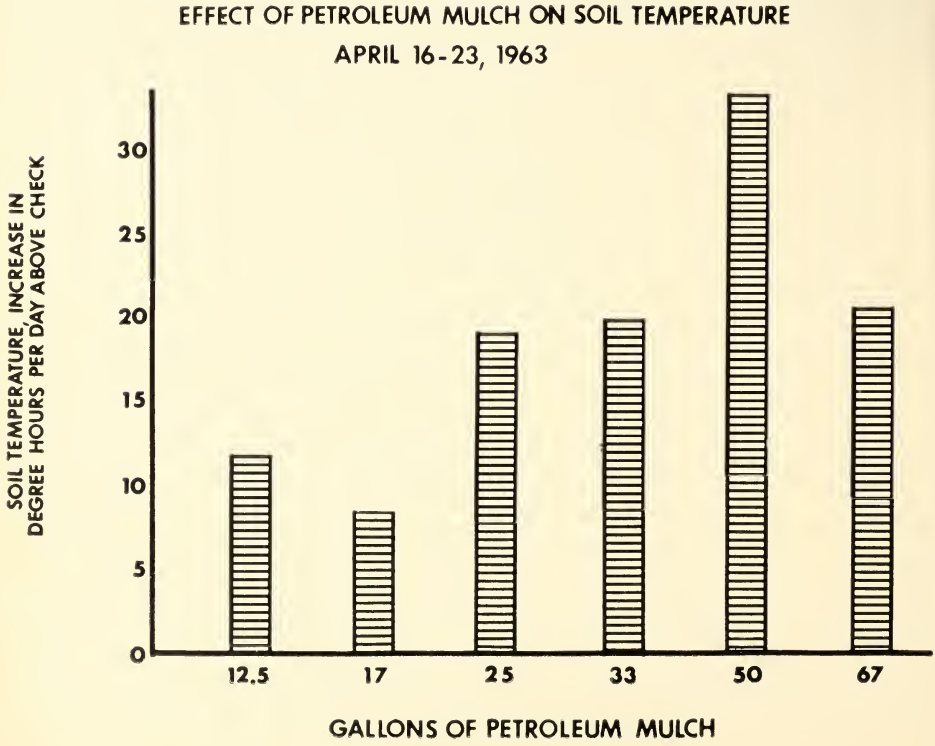

Figure 2. Effect of different rates of petroleum mulch on soil temperatures at the 2-inch level.

Figure 3. Cotton emerging through spot and band applications of mulch. With a soil-incorporated treatment with trifluralin, effective weed control was obtained under the mulch.

dine (trifluralin) were applied in bands 20 inches wide and incorporated into the seedbed with a commercial soil tiller.

Thermistors were placed 2 inches under the center of the seed drill to record temperatures on a multichannel recorder.

In each test, seed were planted 1¼ inches deep in moist soil of preformed beds.

Results and Discussion, 1964. The effects of mulch and herbicide treatments on plant population, stand, and weed control are summarized in Table 3. Early planting combined with very adverse environmental conditions resulted in severe seedling disease losses. Mulch treatments were effective in reducing stand loss. Soil crusting was greatly reduced where mulch was applied. The most encouraging result was the weed control obtained in the mulch-treated areas where the herbicide trifluralin was used. This was the first effective weed control obtained with preemergence herbicides where mulch was used, Figure 3.

Temperature studies, summarized in Table 4, illustrate the effectiveness of the mulch treatments in increasing soil temperatures. During the interval from April 22 to April 27, 3.53 inches of rain were recorded. The temperature data recorded after the heavy rainfall occurred serve to illustrate the durability and effectiveness of the mulch treatment. The rain came as heavy downpours totaling 1.47 inches on the 22nd, 1.04 inches on the 25th, and 3.02 inches on the 26th. This heavy rainfall reduced the mulch's effectiveness, as measured by ability to increase soil temperatures, but the band treatment remained 86 percent effective. The spot treatment remained 69 percent

effective. Following this rainy period soil surfaces on untreated plantings and untreated areas between spot application developed a severe crusting problem. However, mulched areas, free from the crust, were readily penetrated by cotton seedlings and in some cases by weeds.

Table 3. Summary of study evaluating two methods of applying petroleum mulch in combination with two different preemergence herbicides on seedling disease and weed control, 1964.

Treatment					Stand[1]		% freedom
Mulch	Method	Gals./A	Herbicide	Lbs./A[2]	Plants/A	Hills/A[3]	of weeds[4]
None		---	None	-----	12,450abcd	3,409 c	38
None		---	Prometryne	1.25	9,600 cd	3,557abc	90
None		---	Trifluralin	0.62	8,850 d	3,758abc	99
Yes	6" band	25	Prometryne	1.25	15,200a	4,158a	72
Yes	6" band	25	Trifluralin	0.62	12,650abc	4,058abc	98
Yes	9" spot	9	Prometryne	1.25	11,750abcd	3,758abc	76
Yes	9" spot	9	Trifluralin	0.62	14,400ab	4,108ab	98

[1]Plant population per acre, 40-inch rows. Means followed by same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

[2]Band rate, not broadcast.

[3]A perfect stand would be 4,356 hills.

[4]Annual grasses.

Table 4. Comparisons of soil temperatures, at the 2-inch level, under petroleum mulches before and after 5.53 inches of rain. Delta Branch Experiment Station, Stoneville, Miss., April 18-May 5, 1964

	Mulch treatment					
	April 18-21			April 29-May 5		
Comparison	Band	Spot	None	Band	Spot	None
Average 24-hr. temperature, ° F.	72.16	71.84	71.35	70.47	70.20	69.94
Increase above check, ° F.	.81	.49	----	.54	.26	----
Degree hours per day above a 65° F. base	171.84	164.16	152.40	131.28	124.80	118.56
Increase of degree hours per day above check	19.44	11.76	----	12.72	6.24	----
Percent increase	12.76	7.72	----	10.73	5.26	----