THE EFFECT OF 3-PARA-CHLOROPHENYL 1, 1-DIMETHYLUREA ON FRUITING AND FIBER PROPERTIES OF COTTON

by

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INTRODUCTION

Some of the weeds growing naturally with cotton, such as water grass and morning glory, are very troublesome in many respects and in particular with regard to mechanical harvest. The dried leaf residues of water grass are mixed with cotton lint during this process and these impurities are very difficult to remove with standard lint cleaning equipment during ginning. Grassy cotton is discounted about $7.50 per bale (using 1952 parity figures). This would amount to $10.45 per acre in 1952 when the average yield of short staple cotton was 1.395 bales in Arizona (5)[1]. Annual morning glory hinders picking whether it is mechanical or by hand. This weed twines around the cotton plant, tying the rows together.

The cotton plant is very sensitive to most chemicals used for weed control. CMU, a new soil sterilant compound chemically known as 3-para-chlorophenyl 1, 1-dimethylurea, has been found to offer promise for the selective control of weeds in this crop.

The objectives in this experiment were to determine the most effective rate of CMU for controlling water grass in cotton and to study the effect of CMU on fruiting and fiber properties of cotton.

REVIEW OF LITERATURE

Everson and Arle (5) at Mesa, Arizona revealed that CMU gives good commercial control of annual summer grasses and annual morning glory. Different rates of application have been tried, and excellent results were obtained with one-half, one, two and four pounds per acre, but the

1. Numbers in parentheses refer to literature cited

half-pound rate gave only fair control of weeds. All applications were made to the soil just before the last cotton cultivation at lay-by time. Rea (11) during the following year (1952) found that one, and one and one-half pound rates of CMU per acre controlled a mixture of shallow-germinating weeds and grass seedlings in cotton grown on clay soils without damaging cotton.

Very little has been published about the effect of CMU on yield of cotton. From Stamper, Smilie, and Haddon's work (12) in Louisiana, the average weed control and yield of cotton using various application technique with post emergence sprays were as follows:

The average control for grasses at a rate of one pound per acre was 83 per cent and for broad-leafed weeds was 58 per cent with CMU applied on June 5. This was in comparison to a 97 per cent kill of broad-leafed plants when applied on June 26, with nozzles on the sprayer set across the drill. When the nozzles were set parallel to the drill, they reported a 76 per cent kill for grasses when the chemical was applied on June 5, and 100 per cent kill when it was applied on June 26. The corresponding control for broad-leafed plants was 74 per cent and 67 per cent with the chemical applied on June 5 and June 26, respectively. The yield of seed cotton was 2193 pounds per acre when the nozzle was set across the drill in comparison to 2510 pounds per acre when the nozzle was set parallel to the drill.

From this information it is possible to conclude that the date of application of CMU and the kind of nozzle setting used with regard to the drill row are important factors in addition to rate of application in determining the total yield of seed cotton and the percentage control of the anatomically different weed plants.

Rea, Wolters, and Roberts (9) in 1950-1951 treated thick stands of established Johnson grass along fence lines and roadsides with rates of 12 pounds per acre or more. Established Johnson grass was killed and no regrowth or reinfestation occurred during 1951.

Hamilton and Buchholz (7) found that one herbicidal application can replace all post-planting cultivation in establishing food patches for wildlife. Only the initial infestation of annual weeds was controlled. Corn, the most promising crop tested, tolerated CMU applied before, at, and after emergence.

Bucha and Todd (2) applied this new herbicide to many annual and perennial grasses, e-g. Johnson grass, Bermuda grass, quack grass, orchard grass, prairie brome, etc. and found it very effective in killing these grasses.

Similar results with broad-leafed plants have been obtained in a number of experiments. Carlson (3) found that common beet, cabbage, broccoli, turnip, mushmelon, cucumber, lettuce, tomato and parsnip were dead 27 days following CMU treatment and carrot, corn and lima beans were dead in 53 days. The rates used were one, two, and three pounds per acre in 720 gallons of water as a carrier in both pre-emergence and post-emergence application, and the work was done in the greenhouse under high temperature conditions. Soybeans have been found by Hamilton and Buchholz (7) to tolerate only pre-emergence applications.

Preliminary observation in field experiments by Bucha and Todd (2) suggest strongly that CMU is absorbed readily through the root system and is translocated upward to the leaves. This was demonstrated by the experiment run by Haun and Peterson (8):

> Tomato plants thirty-five days old growing in a nutrient solution containing 0.25 p.p.m. of C^{14} ring-labled CMU were used. An appreciable amount of C^{14} were present throughout the aerial portions after an exposure for two hours to the CMU treatment. The concentration of C^{14} in the roots of the tomato increased very gradually throughout the period of treatment whereas the concentration in the aerial parts of the tomato increased quite rapidly during the experiment.

The same results were obtained when older tomato plants were used.

Another experiment by Haun and Peterson (8) using Radioautographs indicates that there was very little movement of C^{14} downward in treated leaves. This suggests that translocation of CMU in plants is mainly in the xylem.

The same results were obtained by using corn and Johnson grass seedlings. The translocation upward was very rapid, but no downward translocation was observed. That CMU may be absorbed by leaves, however, was shown by the work of Bucha and Todd (2). They observed that symptons appeared on sprayed tomato leaves within three days and that the plants were dead in from 7 to 14 days.

King (6) in soil treatment studies with CMU showed that it is also very effective in controlling the germination or seedling development of giant foxtail at rates as low as 2.5 pounds per acre.

Stamper, Smilie, and Haddon (12) in studying the residual action of CMU in Louisiana found that CMU was effective in most tests at rates of one pound to one and one-half pound per acre (broadcast) and was toxic to cotton at two pounds per acre in most tests. As a pre-emergence treatment, residual action at the rates mentioned was longer than any other chemical tested.

Everson and Arle (5) found that in a treatment of four pounds per acre during early June a sufficient breakdown in the three months that followed permitted grass to develop again and therefore they concluded from this that there is no serious residual problem at low rates.

In Florida Bourne and Huntermark (1) found that CMU reduced the amount of flowering in the sugar cane variety Clone.41-42 applied at rates of 8 and 16 pounds per acre. Furthermore, the cane was stunted and resulted in reduced cane and sugar yields.

Haun and Peterson (8) reported that the initial effect of this chemical on plants, generally, is leaftip dieback, beginning on the older leaves. This is followed by progressive chlorosis and retardation of growth, ending in the death of the plant, while Carlson's tests (3) show a yellow transparent leaf tissue followed by necrosis and shriveling of the entire plant.

MATERIALS AND METHODS

Field Treatment: In this experiment, the variety Acala 44 was used because it is well adapted to Arizona conditions and is the recommended variety for most of the cotton producing areas of the state. The experiment was conducted on laveen clay loam soil at the Mesa Experiment Farm in Salt River Valley near Mesa, Arizona. The test was planted March 25, 1953 in a randomized block design with four replications. Each replication consisted of six plots of approximately 11 feet by 23.5 feet. Four rows of cotton were planted in each plot, the inner three of which were harvested for yield and quality tests.

Treatments applied were as follows:

1. Check- weeds allowed to grow
2. Weed free check- weeds controlled by hoeing
3. Half-pound CMU per acre
4. One-pound CMU per acre
5. Two-pounds CMU per acre
6. Four-pounds CMU per acre

The water grass weed growing naturally with the cotton plants was sprayed prior to the last cotton cultivation at "lay-by" time. CMU was applied directly to soil in a spray solution using 40 gallons of water per acre as the carrier. The equipment used was similar to that used in bottom defoliation of cotton. Three 80° fan type nozzles spaced 13 1/3 inches apart between adjacent 40 inch cotton rows were used in this experimental application.

As stated earlier, the objectives in this experiment were to determine the most effective rate of CMU for controlling water grass in cotton and to study the effect of CMU on fruiting and fiber properties of cotton. In an effort to pin down fiber effects, if any, flowers on each plot were tagged as follows:

June 30 - 30 days before lay-by time. Fiber in the middle of secondary thickening period at lay-by time.

July 10 - 20 days before lay-by time. Fiber fully elongated and secondary thickening started at lay-by time.

July 20 - 10 days before lay-by time. Fiber in the middle of elongation at lay-by time.

July 27 - Fiber development just starting on day CMU applied.

A 10-boll sample from each of the tagged series was picked at random from each plot, and analyzed in the laboratory for boll weight, percentage of lint, fiber length, fiber strength and fiber fineness. Procedure for these determinations was as follows:

1. Boll Weight: Grams of seed cotton per boll measured by weighing each ten-boll sample and dividing by ten.
2. Lint Percentage: Weight of lint from each ten-boll sample divided by weight of seed cotton.
3. Fiber Length: Determined by Hertel's Fibrograph, a photoelectric instrument for scanning a fiber sample and tracing a length-and-frequency distribution curve from which fiber length in inches is readily obtained.
4. Fiber Strength: Reported as the Pressley Index and determined by means of the Pressley Fiber Strength Tester.

5. Fiber Fineness: Reported as micrograms per inch of fiber and determined by means of the micronaire.

During its growth, all cotton was treated alike except as otherwise mentioned. No unusual weather conditions prevailed during the growing season, and the first killing frost occurred on November 19, 1953.

The yield figures obtained from each replication were computed on the basis of pounds of seed cotton per plot.

Data in each case were analyzed statistically by use of the Analysis of Variance(13).

EXPERIMENTAL RESULTS AND DISCUSSION

Effect of CMU on Fruiting of Cotton

Boll Weight: Since boll size is an important factor from standpoint of ease in picking, any decrease in boll size will cause difficulty in picking. Also, small bolls cause a reduction in yield if the number of bolls remains constant.

The seed cotton obtained from the four pickings was bulked and the weight per boll and the yield analyzed statistically for the effect of the various rates of CMU treatment. The results are given in Tables 1 and 2 respectively.

There was no significant difference in weight per boll except with the four-pound rate of application of CMU on cotton fiber collected from bolls tagged on July 27. Significance was obtained at the 0.05 level of probability only. It seems that the high rate of application reduced the boll weight when it is applied at the time the fiber development is just starting. This reduction in weight may have been due to a decrease in seed weight, a decrease in lint weight or a decrease in both. Since the weight of cotton seeds constitutes about two-thirds of the total weight of the seed cotton, a reduction in seed size is the most likely explanation for the decreased boll weight.

Yield was also significantly reduced at the four-pound rate. Furthermore, Table 2 shows that the reduction in yield was directly proportional to the rates of CMU applied, starting with the one-pound rate where the reduction in yield was at a minimum to the four-pound rate where the reduction was at its maximum.

Figure 1. Water grass growing with cotton on untreated soil. Mesa Experiment station, Mesa, Arizona.

Figure 2. Successful water grass control as a result of CMU application (one and one-half pounds per acre applied at lay-by time). Mesa Experiment Station, Mesa, Arizona.

Figure 3. CMU symptoms on cotton leaves. (Four pounds per acre applied at lay-by time.) Mesa Experiment Station, Mesa, Arizona.

Table 1. The Effect of CMU Treatments on Boll Weight

TREATMENT	WEIGHT PER BOLL IN GRAMS
1. Check (no treatment)	5.80
2. Weed free check	5.65
3. 0.5 pound of CMU per acre	5.62
4. 1.0 pound of CMU per acre	5.50
5. 2.0 pounds of CMU per acre	5.47
6. 4.0 pounds of CMU per acre	4.72

Analysis of Variance

Source of Variance	Degrees Freedom	Sum of Squares	Mean Square	"F" Value
Total	23	6.63625		
Treatment	5	2.88375	0.57675	3.12178*
Replications	3	0.98125		
Error	15	2.77125	0.18475	

*Significant at the 0.05 level of probability

Table 2. The Effect of CMU Treatments on Yield

TREATMENT	YIELD, POUNDS/PLAT	RANK
1. Check (no treatment)	8.00	2
2. Weed free check	8.09	1
3. 0.5 pound of CMU per acre	7.29	3
4. 1.0 pound of CMU per acre	6.89	4
5. 2.0 pounds of CMU per acre	6.48	5
6. 4.0 pounds of CMU per acre	5.82	6

Analysis of Variance

Source of Variation	Degrees Freedom	Sum of Squares	Mean Square	"F" Value
Total	23	31.42640		
Treatment	5	1.55651	0.311302	6.37*
Replications	3	0.10365		
Error	15	29.76624	1.984416	

*Significant at the 0.05 level of probability

Lint Percentage: Lint percentage is another very important aspect of cotton production. Any reduction in the amount of lint ginned from a given amount of seed cotton will result in reduction of the money return. The decrease in lint may be the result of a number of things, such as a decrease in the average length of fiber, a decreased density of fibers on the seed, an increase in size of seeds, or a combination of any of these factors. An analysis of the data does not show any significant differences in lint percentage due to treatment.

The results show some reduction in lint percentage at the four-pound rate of CMU application on the cotton produced from flowers tagged July 27, but this reduction was not enough to be significant. More precise methods might have resulted in significance and this phase might well bear further investigation.

Effect of CMU on Fiber Properties

Fiber Length: The oldest and most widely known property for evaluating cotton fiber is fiber, or "staple" length. Until recently, spinners who wanted yarns of a given strength specified the length of staple that should be used to produce the desired strength. In order to find the effect of the different rates of CMU application on fiber length, the fiber lengths in inches obtained from the Fibrograph were analyzed statistically. The results are reported in Table 3.

A significant decrease in fiber length at the 0.05 level of significance resulted only from the four-pound rate of CMU application when treatments were made on the day of flowering.

Fiber length is determined by environmental factors as well as by inheritance. Since environment can only affect the length of cotton fiber during the course of its elongation, treatments made at later stages of fiber development would not be expected to affect this property. Consequently, it is not surprising that lint length was not affected on cotton produced from flowers tagged the first two dates. However, the fibers from flowers tagged July 20, were in the middle of the elongation period at the time of treatment and the fact that they were not affected indicates a delayed reaction to the chemical suggestive of an indirect rather than a direct effect of treatment on fiber elongation. A number of environmental and physiological factors are known to affect this property, one of the more important being carbohydrate level. Since treatment at the four-pound rate caused severe defoliation, this may have been the direct cause.

Fiber Strength: Fiber strength is now known to be one of the most important properties for predicting the value of a cotton in the manufacture of textiles. Durable yarns call for strong fibers, which have the added merit of being more easily processed than weak fibers. The samples of fibers from each plot tested for relative breaking strength on the Pressley breaking machine and which was subjected to a statistical analysis do not show any significant difference in the strength of fiber.

The results do indicate a small increase in strength of fiber gathered from bolls of the third and fourth tagging, although this was not of sufficient magnitude for significance at the level of precision attained in these tests. It would not be surprising to find an increase in strength because this property frequently is correlated with fineness.

Fiber Fineness: Fiber fineness is important in spinning in that it affects both skein strength and yarn appearance. The number of fibers that can be packed in a cross section of yarn at a given count depends

Table 3. The Effect of CMU Treatments on Fiber Length

	TREATMENT	FIBER LENGTH IN INCHES	
1.	Check (no treatment)	2	1.080
2.	Weed free check	4	1.105
3.	0.5 pound of CMU	4	1.105
4.	1.0 pound of CMU	1	1.087
5.	2.0 pounds of CMU	3	1.065
6.	4.0 pounds of CMU	5	1.047

Analysis of Variance

Source of Variance	Degrees Freedom	Sum of Squares	Mean Square	"F" Value
Total	23	0.030325		
Treatments	5	0.014700	0.00294	3.9729*
Replications	3	0.004441		
Error	15	0.011183	0.00074	

*Significant at the 0.05 level

upon fineness. The finer the fibers, the greater their number and, it follows, the greater amount of fiber surface area per cross section of yarn. As the size of the yarn diminishes, fiber fineness becomes increasingly important. A sample of fibers from each plot was tested for fineness on the Micronaire, and subjected to a statistical analysis. The results are shown in Table 4.

The table and the analysis of variance show that all rates of CMU application, when applied on the day of flowering, caused an increase in fiber fineness, but there is not enough difference to be considered as significant except with the four-pound rate of application.

The probable effect of CMU on fiber fineness is either on the diameter of the fiber or on the secondary wall thickness of the fibers. The chemical should be active on the day of application in order to effect fiber diameter because this property has been found to be determined about twenty-four hours after flowering. If the chemical has a delayed effect, then the possible explanation should be based on the influence of CMU on the carbohydrate level in the leaves which will in turn cause a thin secondary wall formation. Since the four-pound rate of CMU caused an almost complete defoliation within a few days following treatment, this possibility appears reasonable. Further study would be required to ascertain the exact relationships.

Table 4. The Effect of CMU Treatments on Fiber Fineness

TREATMENT	WEIGHT OF FIBER IN MICROGRAM PER INCH
1. Check (no treatment)	4.41
2. Weed free check	4.32
3. 0.5 pound CMU per acre	4.22
4. 1.0 pound CMU per acre	4.31
5. 2.0 pounds CMU per acre	4.16
6. 4.0 pounds CMU per acre	3.73

Analysis of Variance

Source of Variance	Degrees Freedom	Sum of Squares	Mean Square	"F" Value
Total	23	2.520184		
Treatment	5	1.162034	0.232406	4.023*
Replications	3	0.491617		
Error	15	0.866533	0.057768	

*Significant at the 0.05 level

SUMMARY AND CONCLUSIONS

1. The soil sterilant, CMU, was applied to the soil for the purpose of controlling annual weeds in cotton on Laveen clay loam soil at the Mesa Experiment Farm near Mesa, Arizona. The purpose of this study was to ascertain the effects of such treatment on fruiting and fiber properties of cotton.

2. The fruiting and fiber properties studied were yield, boll weight, lint percentage, fiber length, fiber strength and fiber fineness.

3. Bolls at four stages of maturity at the time of treatment were selected for these studies. These stages were carefully selected to coincide with known stages of fiber development.

4. CMU was applied just prior to the last cultivation of the season at four rates.

5. When applied on the date of flowering, the four-pound rate of CMU significantly decreased yield of seed cotton, boll weight and lint length and significantly increased fiber fineness. Other properties and other treatments resulted in no significant differences in comparison to untreated plots.

6. Certain trends that were not statistically significant indicate that further work is needed in order to better ascertain the precise effects of CMU on fiber qualities.

7. The rate of CMU (one and one-half pounds per acre) now being recommended does not appear to adversely affect fruiting and fiber properties of cotton.

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