

1998 Demonstration Project of Arizona Irrigated Cotton Production

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Abstract

The Demonstration project was conducted on the Demonstration Farm at the Maricopa Agricultural Center. In this project all current guidelines and recommendations disseminated by the University of Arizona were integrated in a systems approach. The management decisions were made by the Extension Specialists in agronomy, entomology, irrigation management, weed sciences, and plant pathology following the University recommendations.

On a 50.5 acre field 80% Bt and 20% non-Bt cotton was planted dry and watered up. Due to the cold spring and sand-blasting, only a stand of 30,900 plants/A could be established with 84% terminal damage. 72 acre-inches of water were used with 41.3 acre-inches in postplant irrigations. Weed control could be achieved with one preplant application and three cultivations. Three sprays against Lygus and one spray against whiteflies were necessary after the thresholds were exceeded. A total of 4120 lb seedcotton per acre were harvested, with 32.7% lint turnout (2.81 bales/A) and 45.9% seed turnout (1891 lb/A).

After harvesting a field budget was established. The variable costs per acre were \$915, the total cost \$1266/acre.

In spite of the lack of replications this project validates the usefulness and compatibility of University recommendations and the potential for integration of all disciplinary guidelines in one system.

Introduction

University recommendations are often offered in a singular disciplinary fashion (e.g., agronomy, entomology, weed control, plant pathology, irrigation etc.), assuming all other crop inputs are managed appropriately. This project attempts to integrate all components in a complete, systems approach. It outlines an example of an irrigated cotton production system for a representative location in central Arizona. It was conducted on the Demonstration Farm of the Maricopa Agricultural Center (MAC) in Pinal County at an elevation of 1,175 ft.

The system integrates all current guidelines and recommendations disseminated by the University of Arizona and their Integrated Cotton Management Team. This team is an interdisciplinary group of more than 20 research and extension faculty housed in nine county offices, three agricultural centers, and six campus departments.

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Methods and Materials

The project was conducted at the University of Arizona Maricopa Agricultural Center (MAC) on a 50.5 acre field that was fallow in the previous year. It was divided into five benches that were dead level. These were labeled with the letters B through F. The length of the irrigation run was 825 ft. The soil is an alluvium soil, and the soil type is Trix or Casa Grande Trix clay loam on four benches and Casa Grande Trix sandy loam on the center bench D. The field was monitored at least once a week for plant development, weeds and/or insects depending on the time of the season. Decisions for field operations were made by Extension Specialists following the University of Arizona recommendations based on the results from the field monitoring.

The field operations were conducted by the farm crew at Mac. Six row equipment was used for all field operations except harvesting, which was accomplished with a two row spindle picker. All sprays were applied by a 47 ft tractor-mounted sprayer with two nozzles per row, that drove in the skip rows.

Weather data for the heat unit calculation (HU, 86/55° F thresholds) was acquired from the AZMET station records located at MAC.

Field Preparation and Planting

The field was ripped in February with a three-shank subsoiler and disced, before a laser leveling. After leveling the field was ripped again in a rectangular pattern and disced again. To facilitate drying, field an s-tine rig was used on the field on April 3. On April 7 the preemergence herbicide (Trifluralin, 0.75 lb a.i./A) was incorporated with the s-tine rig perpendicular to the planting direction.

Due to listing the field with wet soil conditions on April 10, a high amount of clods were present. To break down these clods and prepare a suitable seedbed for dry planting the use of a mulcher and a ring roller were used. Because of this the furrows at planting were very shallow, and many large clods were still present in the furrow. The accuracy in the listing operation was guaranteed by using a precision guidance system on the lister.

A planting window opened around April 19 at 502 Heat Units (HU) after January 1, when the soil temperatures at 4 inches depth first measured in the field exceeded a 60° F daily minimum with a favorable forecast for the following five days. The field was planted with a six-row hill-drop planter on April 21 in a 12 by 2 skip-row pattern with a 40-inch row width in dry soil and then watered-up.

Plant Development and Nitrogen Management

Four of the five benches (78% of the field) were planted with transgenic cotton (var. Delta Pine 33B). The remaining bench (22% of the area) was planted with Delta Pine 5415. Because of a calibration mistake, a rate of only 8.5 lb seed/acre was planted instead of the recommended 12 lb seed /acre. The seedling vigor was low, and most of the plants experienced terminal damage due to sand blasting. On June 17 the field was scouted for plant density and terminal damage. Every bench was divided into quarters, and in each quarter 6.7 ft of row were counted on six locations and checked. Plant densities and terminal damage level were calculated for each quarter. Between 23,100 and 37,800 plants/acre were found with an average of 30,900 plants/acre. At this time, between 67% and 94% (an average of 84%) of the plants had some terminal damage, which was identified by the presence of a forked or missing terminal.

A total of 127 lb N/acre was applied. Fertilizer applications were split on three dates of application. On June 4 and July, 5 44 lb N/acre was side-dressed as ammoniumsulfate (21% N). On June 25 UAN 32 (urea- ammonium-nitrate solution, 32% N) was applied with the irrigation water at a rate of 39 lb N/acre.

Each week beginning on June 24 and ending on September 9, five representative plants out of every bench were mapped. From the plant measurements collected height-to-node ratios (HNR), fruit retention (FR), and the number of nodes above the top (first position) white flower (NAWF) were determined. Although heat units after planting (HUAP) were about 450 HU behind a normal year, the plant development was very close to the baseline for FR and HNRs on an HU-basis. The notable exception was with the last four mapping dates, where the FR-levels dropped significantly from 56% to 28%. To prevent excessive vegetative growth, the plant growth regulator Pix_m (mepiquat chloride) was applied at a rate of 1 pt Pix/A in a tank mix with an insecticide on July 17.

Irrigation Management

Furrow irrigation with siphon tubes was used to irrigate the field. The irrigation water was CAP water that either came out of the farm turnout or was pumped out of an adjacent buffer reservoir. The field was planted dry and watered-up right after planting in every other row. One week later the field was irrigated again (re-run irrigation) to assure uniformity. Due to the shallow furrows and the high amount of clods in the furrows, the first irrigations had to be done with a low water flow in the furrow. Because of this, about 16 - 20 hours were required to finish one run. This resulted in a total water use for the water-up and the re-run irrigations of 30.8 acre-inches, which was 43% of the total seasonal amount of water.

The decisions for subsequent in-season irrigations were made use of regular field inspections for visual appearance, using the AZSCHED Irrigation scheduling software, and probing the soil with augers to determine plant-available water (PAW) levels. The first postplant irrigation was split into two irrigation dates. The bench with the sandy loamy soil (Bench D) required an irrigation on June 3, 5 days earlier than the rest of the field. The second and third irrigations started on June 25 and July 12 or June 22 and July 9 on D. Due in part to the cultivations and soil conditions prevalent prior to these irrigations, an average of 8.1 acre-inches of water was applied to finish these irrigations.

After the third irrigation the decision was made to make the irrigations on one date. To accomplish this, the bench with the sandier soil (Bench D) received another irrigation of 3 acre-inches of water to cover the longer irrigation interval on July 15. It was decided to adjust the irrigation intervals after the 4th irrigation according to the sandier bench and adjust the amount of water to be applied on the benches according to the predicted water use in this period or the amount of water to refill the soil profile. The minimum amount of water that had to be applied was determined by the average water use for cotton as calculated by the AZSCHED program. There were four irrigations following on July 20 and 31 and August 10 and 18 with irrigation amounts from 3.9 to 5.4 acre-inches per event. The final irrigation was on August 28 on the sandy bench D. The other benches received the terminal irrigation on August 31.

There was a total of 72 acre-inches of water applied to the field, of which 41.3 acre-inches applied with postplant irrigations. On the postplant irrigations, an average of 5.2 acre-inches of water per acre was applied per irrigation.

Weed Control

On April 7 Trifluralin was incorporated as a preemergence herbicide with an s-tine rig rectangular to the intended planting direction at a rate of 0.75 lb/A active ingredient. The weed pressure after planting was very low. The emerging weeds could be controlled by two conventional cultivations with a rolling cultivator on May 21 and June 17 and a cultivation with a precision guided Bigham-cultivator, a modified sweep cultivator on July 2. Two benches required a spot treatment against Bermuda grass with 0.5% Select 2EC7 solution.

Pest Management

For pink bollworm control the transgenic Bt cotton variety DeltaPine 33 B was planted on 78% of the total acreage. The remaining 22% (one bench) was planted with a non-Bt cotton variety DeltaPine 5415 to provide a refuge for resistance management. Bolls of the refuge and of the Bt cotton were checked for pink bollworm larvae on August 11 and 25 and on September 10, but no larvae could be found in all cases.

A treatment against Lygus bugs was necessary three times. A call for a treatment was made, when the total number of Lygus adults and nymphs together exceeded the threshold of 15 to 20 per 100 sweeps with Lygus nymphs present and at least 25% damaged squares. To determine this number, the field was swept at least weekly between June 17 and August 27. After detecting increasing amounts of Lygus in some sweeps starting on July 9 2x25 or 4x25 sweeps with a standard sweep net were taken from every bench and counted for Lygus and other insects. To get the percentage of damaged half-grown squares about 25 squares were taken at random from each bench and checked for damage internally by splitting.

The first treatment was made on July 17 with 34 oz/A of Vydate⁷ (1.0 lb a.i./A). To reduce costs of application the first Lygus spray was made in combination with a plant growth regulator (Pix⁷, 1 pt/A). All sprays were applied with a 47 ft tractor-mounted sprayer, that drove in the skip rows, delivering 22.5 GPA volume. At this time, a total of 15.7 Lygus with 11 adults and 4.7 nymphs per 100 sweeps were found and 30% of the half-grown squares were damaged. After this spray, the number of Lygus dropped to a total of 7.8 with 7.3 adults and 0.5 nymphs per 100 sweeps on July 24. The number of damaged squares was 38%.

The threshold was exceeded on July, 30th with a total number of 23.5 Lygus per 100 sweeps (11.3 adults, 12.3 nymphs) and 44% damaged squares. That same day, Orthene⁷ was sprayed at a rate of 1.11 lb/A (1 lb a.i./A). On August 7 14 Lygus adults and 0.3 Lygus nymphs were found per 100 sweeps. The percentage of damaged squares increased to 49%. After this date no checks for damaged squares were made.

The third and final spray for Lygus was made with Vydate⁷ at 34 oz/A on August 15, when a total of 29 Lygus (14 adults and 15 nymphs) were found per 100 sweeps on August, 14. The Lygus number dropped to a total of 16.3 Lygus (11.3 adults and 5 nymphs) per 100 sweeps on August 18. After this the Lygus number increased to 27.8 total (19.8 adults, 8.0 nymphs) on August 21 and 41.8 total (10.3 adults, 31.5 nymphs) per 100 sweeps on August, 27. At this point in time the developmental stage of the cotton did not justify another treatment for Lygus.

Whiteflies were controlled with a single spray of Knack⁷, an insect growth regulator, at 8 fl.oz/A on August 5. The threshold for a whitefly treatment was reached when 40% of the leaves were infested with 3 or more adults and 40% of the leaf-disks were infested with 1 or more large (3rd or 4th instar) nymphs. Whiteflies were sampled by making 30 leaf-turns in every bench on each sample date. The number increased from 48% infestation by adults and 7% infestation by nymphs on July 27 to 67% for adults and 15% for nymphs on July 29 to 67% for adults and 47% for nymphs on August 3. After the treatment on August 5 the infestation dropped to 31% for adults and 45% for nymphs on August 14 and 6% for adults and 1% for nymphs on August 24. On the last sample date on September 9 12% of the leaves were infested with adults, and no living nymphs were found.

Defoliation and Harvest

After the last irrigation the plants on the sandier part of the field (Bench D) reached the appropriate condition for defoliation on September 24. A defoliant application was made with 10 oz Ginstar⁷/acre with a spray volume of 22.5 GPA with a 47 ft tractor-mounted sprayer. The remaining areas to the west (Benches B, C) were sprayed with the same amount of Ginstar⁷ on October 2. Due to an adjacent field of sorghum to the east, it was decided to spray a tank mix of 0.125 Dropp⁷ lb/acre plus 1 pt DEF⁷/acre to defoliate benches E and F to the east of Bench D. Benches E and F and bench B on the west required an additional application of 5 lb a.i. sodium chlorate/acre. The cotton defoliated first (Bench D) was harvested on October 14 and 15, bench C, that did not require a treatment with sodium chlorate, on October 20. The harvest was finished on October 28 and 29 on the remaining benches. The field was harvested with a two-row spindle picker utilizing a module builder. The modules were then transported to a commercial gin. The cotton is marketed by a marketing organization (Calcot). After the harvest the stalks were shredded, the roots were pulled and the field disced.

From every bench 3x8 rows were harvested and weighed separately in a trailer, and samples of this cotton ginned at the GLP-compliant gin at the MAC to determine the yield and the lint and seed turnout per bench. The average yield on the samples was 4101 lb/A seedcotton with a low of 3487 lb/A on bench D and a high of 4432 lb/A on C. The average seed turnout was 57.8% with a variation from 57% to 59%, this is between 2526 lb/A on C and D 1988 lb/A seed on D with an average of 2367 lb/A. The lint turnout varied from 31% (C) to 34% (D, E) with an average of 32.7%. The average calculated lint yield was 2.79 bales/A with a variation between 2.47 bales/A (D) and 3.03 bales/A (E). The statements from the commercial gin resulted in a yield of 4120 lb/A seed cotton with 2.81 bales/A lint (32.7% lint turnout) and 1891 lb/A seed (45.9% seed turnout) .

Budget

All the purchases for the field were recorded, and a budget was established. The costs for the field operations were calculated by using the hourly costs out of the Arizona Farm Machinery Bulletin and the actual hours needed on the field for these operations.

The costs for fertilizer without application were \$43/A, for seed without planting \$8/A. \$3/A had to be spent on herbicides, \$12/A for plant growth regulators, \$74/A for insecticides, and \$14/A for Defoliant. These costs are all without application. The total water costs at a price of \$34/acre-foot were \$238/A. The variable equipment costs (repairs, fuel and oil) without the costs for the operator run up to \$126/A. \$210 had to be paid in wages including benefits at a rate of \$9.84/hour. The other costs totaled \$185/A with \$83 for ginning, \$32 license fee for Bt cotton, \$25 water assessment, \$25 for scouting and plant mapping, and \$20 for growers' association fee and classing of the bales. This totals to \$915/A on variable costs.

The fixed costs can be split up into cash costs and calculatory costs. For the equipment, the fixed costs are taken out of the Arizona Farm Machinery Cost Bulletin. The other fixed costs are standardized assumptions for an average farm. Cash costs total \$214/A and consist of \$121 for fixed equipment costs, \$20 property taxes, and \$73 for general farm maintenance and overhead costs. The calculatory costs of \$137/A can be split up into \$50 for the opportunity interest for land and operation expenses (= variable costs) and \$87 as management costs. The total costs ran up to \$1266/A for this field.

The variable equipment cost per acre summarized by class are \$48.88 for planting, \$31.43 for growing, \$31.74 for Harvest, and \$14.26 for post harvest operations.

The break even price per pound of cotton lint for the obtained yield would be \$0.77/lb with cotton seed prices of \$160/ton and a PFC-payment of \$75 per acre. At this price the whole input including management and opportunity costs would be paid. The short term price for lint or production threshold would be at the above assumptions, \$0.51/lb lint. Below this price the variable costs of the production are higher than the returns.

Discussion

The primary purpose of this project was to integrate all of the University of Arizona recommendations for cotton in one field on a commercial level and evaluate the compatibility of the disciplinary recommendations in a total integrated system. Due to the fact that this was a commercial scale demonstration effort, therefore lacking replications and statistically valid experimental design, results are indicative of general trends. Any statements or conclusions relative to economics or profitability of this cotton production situation is unique to this particular case. Extensions of these results to other fields or farms in Arizona must be done with caution. For other fields or growing regions the specific management practices and production budget would require site-specific adaptations to the conditions, prices and their use of appropriate inputs and resources.

In spite of the lack of replications this project validates the usefulness and compatibility of University recommendations and the potential for integration of all disciplinary guidelines in one system.

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