TEXAS A&M AGRILIFE RESEARCH & EXTENSION

COTTON ENTOMOLOGY RESEARCH REPORT 2023

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TEXAS A&M AGRILIFE RESEARCH, CLIFF LAMB, DIRECTOR
THE TEXAS A&M UNIVERSITY SYSTEM, COLLEGE STATION, TEXAS

COTTON ENTOMOLOGY PROGRAM

RESEARCH ACTIVITY ANNUAL REPORT

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SUBMITTED TO:

PLAINS COTTON IMPROVEMENT COMMITTEE
PLAINS COTTON GROWERS, INC.

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Introduction

Plains Cotton Growers, Inc. (PCG) has been a strong and consistent supporter of cotton insect research and extension activities in west Texas. Most notably, PCG was instrumental in securing state funds for the Boll Weevil Research Facility at the Lubbock Center and provided both financial and political support to conduct boll weevil biology and ecology research even before the boll weevil became a significant economic pest of the High Plains region. After the initial entry of the boll weevil into the eastern edge of the High Plains, PCG promoted and along with USDA-APHIS administered the boll weevil diapause suppression program involving a team effort that continued to include Texas A&M University. PCG also supported Texas Cooperative Extension (now Texas A&M AgriLife Extension Service) efforts to annually evaluate the diapause suppression program, conduct applied research trials to develop boll weevil management practices that would enhance the diapause suppression program's efforts, and in the 1990s supported an annual survey of High Plains overwintering sites and grid trapping of cotton across the High Plains area. The team effort of PCG, Texas A&M AgriLife Research and AgriLife Extension Service over several decades resulted in a comprehensive understanding of boll weevil ecology and behavior. Under the strong and cooperative leadership of PCG, the boll weevil eradication program for the High Plains area progressed much more rapidly than anticipated. Now, the successful boll weevil eradication program has eliminated the boll weevil from this region for two decades.

With a successful boll weevil eradication program and increased adoption of the transgenic *Bt* technology (now >70%), the cotton insect research and extension program focus has changed considerably during the last 20+ years. Our current research/extension focus is on developing ecologically intensive strategies for cotton pest management, including crop phenology, cultivar, non-crop habitat, irrigation, and fertility management towards reducing insect pest pressure. Our research has demonstrated the need for continuing investigation of basic behavior and life patterns of insects while having strong field-based applied research to bridge the gap between basic, problem-solving science and producer-friendly management recommendations. We have assembled a strong group of people to work as a team to examine multiple disciplines within the broad theme of Cotton IPM. We invest considerable time and manpower resources in investigating the behavior and ecology of major cotton pests of the High Plains with the goal of developing management thresholds based on cotton production technology and economics, with particular focus on limited water production system. Our Program has successfully leveraged research funds based on the funding provided by PCIC to support our research effort. We are excited about and greatly value our Cotton Entomology research and extension partnerships with multidisciplinary scientists at the Texas A&M AgriLife Research Center in Lubbock and statewide field crop entomologists, together with area IPM agents in the region, to continue this partnership as we challenge ourselves to deliver the best cotton insect-pest management recommendations to our Texas High Plains producers. Together, we have maintained the Texas High Plains area as a characteristically low cotton insect-pest prevalence region in the U.S. cotton belt.

Texas A&M AgriLife Research & Extension Center at Lubbock

COTTON ENTOMOLOGY PROGRAM

Megha N. Parajulee, Ph.D.
Professor, Faculty Fellow, and Texas A&M Regents Fellow

PROGRAM OVERVIEW: The Cotton Entomology Program at Lubbock combines basic and applied research with strong outreach, industry, and grower partnerships to produce information to enhance the ability of the cotton industry in the Texas High Plains to mitigate cotton yield losses due to insect pests through the use of ecologically intensive integrated pest management. Selected projects of the Program are briefly highlighted in this exhibit.

EFFECT OF NITROGEN FERTILITY ON COTTON CROP RESPONSE TO INSECT DAMAGE

A long-term study investigating the effects of differential nitrogen fertility on cotton aphids and cotton fleahopper population dynamics in a typical drip-irrigation Texas High Plains cotton production system has been ongoing since 2002. Differential nitrogen fertility (0, 50, 100, 150, and 200 lbs N/acre) is being examined for its effect on cotton plant physiological parameters, thereby influencing cotton insect injury potential and plant compensation. Recent focus has been to examine the effect of residual nitrogen on crop response to simulated cotton fleahopper damage.

Cotton fleahopper augmentation in multi-plant cages to quantify the response of variable rates of N to FH injury

SEASONAL ABUNDANCE PATTERNS OF BOLLWORM AND TOBACCO BUDWORM MOTHS IN THE TEXAS HIGH PLAINS

A long-term study is investigating the seasonal moth flight activity patterns of bollworm and tobacco budworm in the Texas High Plains. The regional adoption of cotton and corn cultivars incorporating *Bt* technology has contributed to reduced level of these lepidopteran pests in recent years; however, constant threat of insect resistance to transgenic technology and diminishing underground water availability for irrigation is necessitating lower crop inputs, such as transgenic seed costs, for increasing dryland crop acreage, increasing the importance of these pests.

Texas Pheromone (TP) and "Bucket" traps used to monitor moths

COTTON FLEAHOPPER SUSCEPTIBILITY OF PRE-FLOWER COTTON UNDER LIMITED IRRIGATION PRODUCTION

The objective of this project is to investigate the growth and fruiting response of cotton after cotton fleahopper infestation at three discrete cotton fleahoper susceptible stages (prior to visible squares, 1-2 square, and 3-4 square stages) of cotton under three irrigation water levels. We also quantify cotton compensatory potential following cotton fleahopper induced square loss under phenological stage x irrigation treatments.

Cotton fleahopper augmentation at three crop phenological stages and inspection to determine insect colonization and crop injury

INTERACTIVE EFFECT OF COVER CROPS AND IRRIGATION ON COTTON AND INSECT-PEST MANAGEMENT

Reduced water availability, low rainfall coupled with wind erosion of topsoil, higher pumping cost of limited water, and increased input cost limit cotton productivity in the Texas High Plains and correspondingly lower profit margins, warranting for higher water use efficiency in our crop production. The study aims to: 1) quantify the impact of cover crops on early seedling growth and cotton susceptibility to thrips infestations across three irrigation water availability, and 2) evaluate the interactive effect of cover crop x irrigation water on seedling vigor, thrips infestations, and seasonal plant phenology impacting cotton lint yield and fiber quality. Two cover crops (terminated rye and wheat) and a control (no cover crop) will be deployed under three irrigation treatments (full irrigation, supplemental irrigation, and dryland). Two thrips infestation treatments (thrips augmented versus spray-control) will be deployed within each of the 9 main plot treatments (3 water levels x 3 cover crops x 2 thrips treatments = 18 treatment units), replicated four times (72 plots).

Terminated cover crops x Irrigation treatments affecting cotton phenology, early-season insect abundance, and crop compensation

STATEWIDE RESEARCH-EXTENSION PROJECT TO ADDRESS CURRENT COTTON INSECT MANAGEMENT ISSUES

Multi-year statewide studies are being conducted at several Texas locations to represent cotton fields surrounded by variable vegetation/crop complexes and regional insect population pressure in cotton. Study objectives are to evaluate the value of cover crop, cultivar sensitivity to cotton fleahopper herbivory, fleahopper threshold, and cotton bollworm pyrethroid resistance. Research and Extension entomologists from south, central, and north Texas, including IPM agents from throughout Texas cotton production regions collaboratively conduct research to address these project objectives. Lubbock Cotton Entomology Project focuses on cover crop, cotton fleahopper cultivar susceptibility, and threshold.

Cover crop x irrigation evaluation of thrips abundance, seedling health, and crop compensation

EFFECT OF NITROGEN FERTILITY ON COTTON CROP RESPONSE TO SIMULATED COTTON FLEAHOPPER AND LYGUS DAMAGE

M.N. Parajulee, D. P. Dhakal, Raju Shrestha, Amanda Sieps, and K. L. Lewis

Objective: The study was designed to evaluate the effect of artificial injury to cotton squares and bolls mimicking acute cotton fleahopper and *Lygus* damages, respectively, under variable nitrogen application rates on cotton fiber yield and quality.

Methodology: A high-yielding cotton cultivar, DP1820B3XF, was planted at a targeted rate of 47,000 seeds/acre on May 19, 2023. The experiment was laid out in a split-plot randomized block design with five nitrogen fertility rate treatments (0, 50, 100, 150, and 200 lb N/acre) applied for 21 years as main plots (16-row plots) and three fruit loss treatments (artificial cotton square injury treatment mimicking acute cotton fleahopper infestation, 20% boll removal treatment to mimic late-season Lygus infestation, and control) as sub-plots with four replications (total 60 experimental units). Within each of the five main-plot treatments included pre-bloom side-dress applications of N augmentation using a soil applicator injection rig on July 18, 2023. Pre-treatment soil samples (consisting of three 0 to 12 and 12 to 24-inch depth soil cores each) were collected from each of the 20 main-plots on July 7, 2023. Ten leaves per plot were collected three times (July 28, August 22, September 20) for leaf dry weight and nitrogen analysis. Within each main-plot, three 10-ft. sections of uniform cotton were flagged in the middle two rows, each receiving hand removal of 100% cotton squares three weeks into squaring (July 28), 20% bolls removed from top canopy of the plants at crop cut-out (August 22) or control (no square or boll removal). Treatment plots were hand-harvested on October 31 for lint yield and fiber analysis.

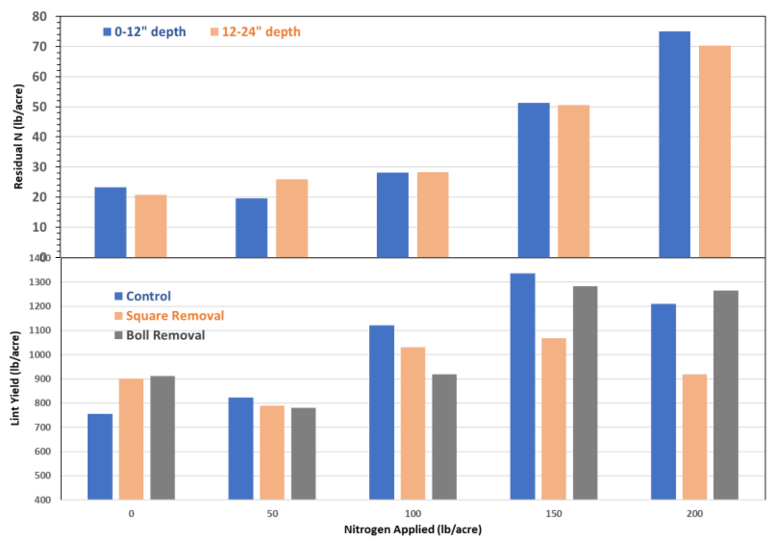

Fig. 1. Residual N (lb/A) at season's end and lint yield (lb/A) affected by simulated cotton fleahopper and Lygus damage across five variable N rates.

Results: Significantly higher soil residual nitrogen was recorded from plots that received high rates of soil N augmentation (~50 lb and ~70 lb/A residual N in 150 and 200 lb/acre N plots, respectively) than zero, 50 and 100 lb/A N plots. In control plots, lint yield increased with increased N rates with maximum yield at 150 N/A plots, and then slightly declined at 200 lb/A plots. Cotton fleahopper simulated plots resulted in reduced yield at the two highest N application rates while no significant yield reduction was observed at Lygus simulated plots at any of the five applied N rates (Fig. 1). It appears that the applied N rate of 100 lb/A is the critical point for cotton agronomic performance that allowed for full compensatory growth and reproduction following simulated cotton fleahopper square abscission. However, cotton was unable to fully compensate for the square loss at high N rates, likely due to a greater proportion of plant energy invested in supporting vegetative structures in larger plants compared to reproductive compensation.

TITLE:

Cotton yield response to simulated cotton fleahopper and western tarnished plant bug infestations as influenced by irrigation level and cultivar treatments, Lamesa, TX, 2023.

AUTHORS:

Megha Parajulee – Professor, Faculty Fellow, and Regents Fellow
Dol Dhakal - Research Specialist II
Raju Sapkota – Research Associate
Wayne Keeling - Professor

MATERIALS AND METHODS:

Plot Size:	4 rows by 300-700 feet, 3 replications
Planting Date:	May 16, Rye cover planted
Varieties:	DP 2143NR B3XF FM 2498 GLT

Herbicides:	Roundup 32 oz/A	4/6/23
	Caparol 24 oz/A + Gramoxone 22 oz/A	5/17/23
	Roundup 32 oz/A + Liberty 22 oz/A	6/14/23
	Roundup 32 oz/A + Liberty 32 oz/A + Warrant 48 oz/A	7/20/23

Fertilizer: 90-34-0

Irrigation:

	Low	Base	High
Preplant/Emergence	4.25”	4.25”	4.25”
In-season	4.9”	7.0”	9.10”
Total	7.25”	14.2”	16.5”

Treatments: Three treatments included c*ontrol, manual removal of 100% squares three weeks into squaring (July 14) to time cotton fleahopper susceptible stage, and removal of 20% bolls from the top of the plant to simulate Lygus infestation (August 17)*.

Harvest date: October 20 (hand-harvested)

Effect of manual removal of early-stage versus late-stage fruits was evaluated on two cotton cultivars, FM 2498 GLT and DP 2143NR B3XF, as influenced by two irrigation (low and high) water levels. The experiment comprised of two water levels, two cultivars, and three simulated fruit loss events [control, pre-flower 100% square loss mimicking the cotton fleahopper injury-induced loss, and 20% small bolls (<3 cm diameter) loss mimicking the Lygus boll injury-induced small fruit abortion at cut-out], replicated three times, totaling 36 plots. The test plots were monitored for the occurrence of any other insects, but no such occurrences were observed during the growing season.

RESULTS AND DISCUSSION:

Combined over two cultivars and three insect simulation treatments, significantly higher lint yield was recorded from 'high' water regime (629 lb/acre) compared to that in 'low' water regime (389 lb/acre). Lint yield was abnormally low in 2023 due to prolonged drought during the growing season. Nevertheless, the insect simulation treatments showed characteristic treatment differences. That is, the late season fruit removal mimicking Lygus injury did not significantly reduce the lint yield regardless of the irrigation water treatment (Low water: uninfested control – 419 lb/acre, Lygus-simulated -383 lb/acre; High water: uninfested control – 687 lb/acre, Lygus-simulated – 724 lb/acre), whereas an early season fruit (square) removal mimicking cotton fleahopper injuiry reduced lint yield (Low water: uninfested control – 419 lb/acre, cotton fleahopper-simulated -363 lb/acre; High water: uninfested control – 687 lb/acre, cotton fleahopper-simulated – 476 lb/acre) under high water regime. The effect of simulated cotton fleahopper was much more pronounced under high irrigation production regime (Fig. 1), indicating a greater pest risk at high irrigation production regime for pre-flower cotton. The effect of insect injury simulation was similar in both cultivars; however, DP 2143NRB3XF appeared to be slightly more vulnerable to late season Lygus infestation than FM 2498GLT and the effect was more pronounced under deficit irrigation production condition (Fig. 2).

All treatment combinations (2 Water x 2 Cultivar x 3 Insect Infestation treatments), except for DP 2143NRB3XF in Low water treatment, resulted in micronaire values >4.2 (4.3 in DP 2143NRB3XF Low water-Control to 5.48 in FM 2498 GLT-High Water-Lygus Simulation), rendering most of the test crop to a discount range. Irrigation water treatment significantly impacted the Short Fiber Index (SFI), with SFI values of 10.76 in 'high' water and 12.96 in 'low' water treatments. Similarly, late-season boll removal improved SFI (10.3) compared to control (12.65) and early-season square removal (12.65), suggesting a significant fiber quality impact by early-season cotton fleahopper infestation that with high severity. Similarly, late-season boll removal as simulated Lygus damage enhanced fiber strength (30.47 gram/tex) compared to fleahopper-simulated square removal (27.47 gram/tex) or uninfested control (27.14 gram/tex) (Fig. 3). Overall, 'high' water plots produced stronger fiber (29.7 gram/tex) than 'low' water plots (27.02 gram/tex). A significant interaction of water x cultivar x insect simulation influenced fiber strength. Five of the 12 treatment combinations resulted in strong or very strong fiber, five produced average fiber, and two weak fiber (Fig. 3).

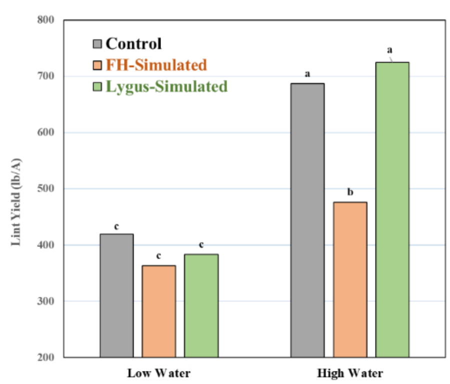

Figure 1. Average lint yield under low and high irrigation regimes following cotton fleahopper and Lygus infestation simulation versus control, Lamesa, Texas, 2023.

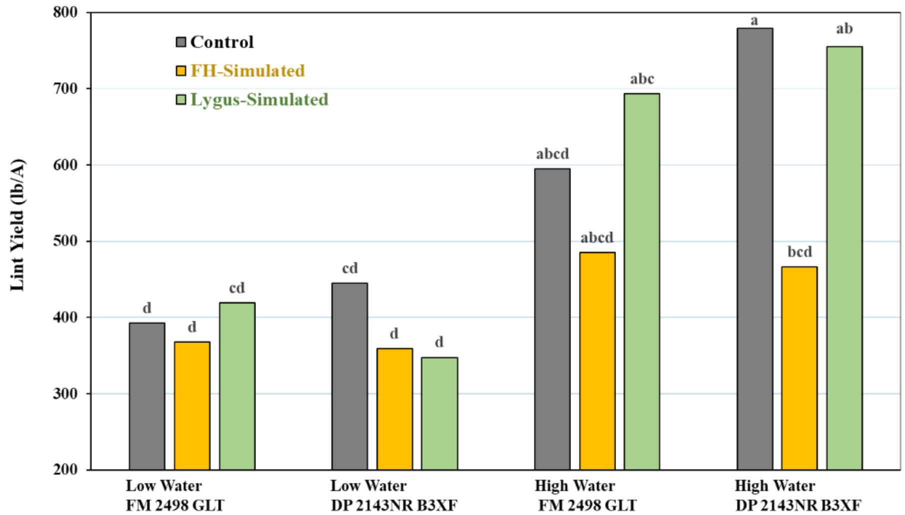

Figure 2. Average lint yield influenced by simulated cotton fleahopper versus *Lygus*-induced fruit removal in two cotton cultivars under low and high irrigation regimes, Lamesa, Texas, 2023

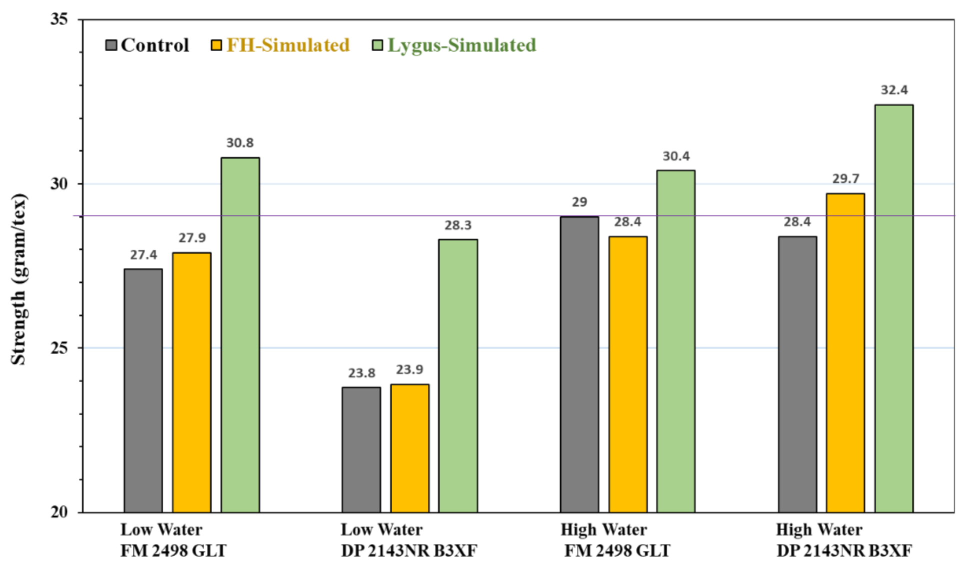

Figure 3. Average fiber strength values (grams/tex) influenced by early-season simulated cotton fleahopper damage and simulated *Lygus*-induced fruit removal in late season in two cotton cultivars under low and high irrigation regimes, Lamesa, Texas, 2023. Interpretation of fiber strength: Very strong ≥31, Strong 29-30, Average 26-28, Intermediate 24-25, and Weak ≤23.

Cotton fleahopper susceptibility and compensatory potential of three distinct phenological stages of pre-flower cotton in water-deficit production scenario

Cotton Incorporated – Core Program
Project Number: 20-246

Megha N. Parajulee
Texas A&M AgriLife Research and Extension Center, Lubbock, Texas

Project Summary

The recent increase in limited-irrigation cotton production in the Texas High Plains has demanded development of pest management strategies at low-input production system. Our current understanding is that cotton fleahoppers can be injurious to cotton during 3-weeks of squaring until about the appearance of first flower. That may warrant possible management of cotton fleahoppers up to three discrete stages of cotton prior to flowering as stated earlier. Impact of cotton fleahoppers on pre-squaring stage, especially when fleahoppers migrate to cotton prior to the occurrence of visible squares, and late squaring/first-flower stage is not quantified. Our earlier work on cotton fleahopper compensation studies suggest that cotton plants can tolerate up to 20% fruit loss. This project aims to investigate the growth and fruiting response of cotton after cotton fleahopper induced square loss at three discrete cotton fleahoper susceptible stages of cotton under deficit-irrigation scenario. The specific objectives of the study were to 1) quantify the damage potential of cotton fleahopper (feeding injury and/or square abortion) at square initiation (prior to visible squares), 1-2-square, and 4-5-square stages of cotton under dryland, deficit irrigation versus full irrigation, 2) determine cotton growth parameters and fruiting profiles as influenced by cotton fleahopper injury at three discrete cotton fleahopper susceptible stages of cotton under deficit-irrigation scenario, and 3) quantify cotton compensatory potential following cotton fleahopper induced square loss under phenological stage x irrigation treatments.

This study generated a significant amount of data to elucidate the damage potential of cotton fleahoppers at three discrete cotton fleahopper susceptible stages under three drought-stress conditions, including dryland (high drought stress), low/supplemental irrigation (medium drought stress) and full irrigation (no or minimal drought stress), and cotton's response to cotton fleahopper injury under each production scenario. The data regarding how the cotton fleahopper injury x drought-stress conditions impact cotton performance at three discrete phenological stages would be useful in making management decisions based on economic models.

Averaged over a 4-year period (2020-2023), cotton fleahopper infestation at pre-squaring stage reduced cotton lint yield significantly under dryland (166 lb/A) and full irrigation (189 lb/A) conditions, whereas limited irrigation production conditions showed no significant effect of cotton fleahoppers. It is plausible that fleahoppers fed on growing terminals and likely damaged the invisible squares which ultimately reduced the lint yield. Cotton fleahoper infestations also impacted fiber quality, with improved micronaire values under full irrigation. The four-year study clearly suggests that there is an apparent interaction between fleahopper-induced injury to cotton and irrigation water availability for plants to overcome the injury effect, thereby influencing the lint yield and fiber quality.

Introduction

The cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), is a significant economic pest of cotton in the Texas High Plains. Injury by cotton fleahoppers to squaring cotton often causes excessive loss of small squares during the early fruiting period of plant development (first 3 weeks of squaring). There has been some evidence that cotton fleahoppers also infest pre-squaring cotton plant terminals, perhaps when squares are developing on the plant. Both adults and immatures feed on new growth, including small squares. Greater damage is observed on smooth leaf varieties than on hirsute varieties, which may extend the susceptible period into early bloom, especially under a high-input production regime. Generally, cotton is affected by cotton fleahopper injury from about the fifth true leaf through first week after initiation of flowering. Squares up to pinhead size are most susceptible to damage, and yield loss is most likely from feeding during the first three weeks of fruiting. Cotton fleahopper damage also delays crop maturity and thus increases the vulnerability of cotton to late season pests such as Heliothine caterpillars and *Lygus* bugs, particularly when natural enemies are destroyed by insecticides directed against cotton fleahoppers.

Predominantly, cotton fleahoppers feed upon pinhead-sized or smaller squares, which results in abortion of these young fruits, thereby impacting yields. While cotton fleahopper feeding preferences serve as a baseline for their management in cotton fields, a detailed understanding of cotton plant responses to fleahopper damage remains unachieved. Because cotton vulnerability to cotton fleahoppers spans over a period of 3-4 weeks, information on acute infestation of cotton fleahopper at phenologically-specific crop stages may help cotton producers make appropriate management decisions in low-input, water-deficit production systems. Cotton plant growth is sensitive to numerous environmental and management input factors, particularly irrigation and cultivar traits. Cotton growth responses to various input factors are well-documented and growth models have been developed. However, the specific cotton plant responses to cotton fleahopper injury at phenologically discrete cotton fleahopper susceptible stages remain uninvestigated. This research project proposes to evaluate the cotton crop growth parameters and lint yield following cotton fleahopper acute infestations at three distinct cotton fleahopper susceptible cotton stages (pre-squaring, 1-2-square stage, 4-5-square stage) under deficit-water versus full-irrigation production regimes.

Methodology

The study was conducted at the Texas A&M AgriLife Research farm in Lubbock. A 5-acre subsurface drip irrigation system has been in place for this study. Main-plot treatments included full irrigation, supplemental irrigation, and dryland. The full irrigation water level was created via 90% replenishment of evapotranspiration (ET) requirement for THP, whereas the supplemental irrigation treatment received 30% ET replenishment. Cotton cultivar DP 1820B3XF was planted on 18 May 2020. In 2021, cotton cultivar DP1845B3XF was planted on 18 May, but the crop was destroyed by repeated rain and hailstorm events and the test was replanted on 9 June. Cotton cultivars DP1646B2XF and DP2020B3XF were planted on May 16 and May 18 in 2022 and 2023, respectively. Sub-plot treatments included three discrete phenological stages of cotton that is considered susceptible to cotton fleahopper damage: 1) prior to the occurrence of visible squares on seedling cotton or “pre-square” cotton, 2) cotton at 1-2 visible squares stage or early squaring stage, and 3) cotton with 4-5 squares and close to the occurrence of first flower or late squaring).

Two 3-ft sections of uniform cotton were flagged in the middle two rows of each treatment plot (3 irrigation treatments x 3 phenological stages x 2 insect augmentation treatments x 4 replications = 48 experimental units) for insect treatment deployment. At each phenological stages, 5 cotton fleahopper nymphs per plant versus no fleahopper augmentation as control were deployed in these designated row sections to simulate an acute infestation of cotton fleahoppers.

Woolly croton, a cotton fleahopper weed host, was harvested from locations in and near College Station, Texas, in early February and stored in cold storage until fleahoppers were needed for the study. Conditions conducive to cotton fleahopper emergence were simulated in a laboratory environment to induce hatching of overwintered eggs embedded in the croton stems, and emerged cotton fleahoppers were subsequently reared using fresh green beans as a feeding substrate.

Considerable effort was expended to ensure synchronization of rearing efforts with cotton crop development for optimal release timing for each of the three cotton phenological stages. A single release nymphal cotton fleahopper was timed to simulate the acute heavy infestation of cotton fleahoppers (3-4 days of feeding) at each stage. This arrangement ensured significant damage on treatment plots to quantify the variation in damage potential as influenced by cotton phenological stage. The actual release dates in 2020, 2021, 2022, and 2023 were 20 June, 2 July, 30 June, and 2 July (pre-square), 1 July, 16 July, 15 July, and 8 July (early square), and 21 July, 26 July, 22 July, and 25 July (late square), respectively. Cotton fleahopper rearing cages were installed about a month prior to the first release (e.g., cage installation on 20 May 2020 for 20 June 2020 release) and staggered the cage installation for the next 4-5 weeks to ensure a continuous supply of cotton fleahopper nymphs for the study.

The release was accomplished by manually placing second- to third-instar cotton fleahopper nymphs from the laboratory colony onto the terminals of plants in each treatment plot at the rate of 5 nymphs per plant; the control plots received no fleahoppers and were kept fleahopper-free during the entire study period. Because natural infestation of cotton fleahopper was absent at the experimental farm, the control plots received no insecticidal intervention. An insecticide (acephate 97% 6 oz/acre) was used to kill all remaining cotton fleahoppers after the one-week feeding period in all experimental units to ensure complete removal of released cotton fleahoppers. The entire test was kept insect-free for the remainder of the study to isolate the effect of cotton fleahopper injury only.Data collection included monitoring of flowering patterns, fruit abscission, and plant height. The flower monitoring was initiated on 20 July (2020), 7 August (2021), 18 July (2022), and 24 July (2023), conducted every 2-3-day intervals, and ended on 19 August (2020), 10 September (2021), 26 August (2022), and 1 September (2023) with total of 14, 17, 18, and 18 sample dates for 2020, 2021, 2022, and 2023, respectively.

Harvest aids (Boll’d® 6SL (the openingn [(2-chloroethyl) phosphonic acid] @ 1 qt//acre (boll opener) and Folex® 6 EC (S, S, S-tributyl phosphorotrithioate) 1 pint/acre (defoliant) on 12 October 2020; Boll’d® 6SL (Ethephon [(2-chloroethyl) phosphonic acid] @ 1 qt//acre (boll opener) and Gramoxone® SL 2.0 (Paraquat dichloride (1,1’-dimethyl-4,4’-bipyridinium dichloride) on 25 October 2021 and 5 November 2021, respectively; Boll’D @ 1qt/acre + ET®X (pyraflufen ethyl) @ 1.5 oz./acre and Gramoxone® SL 2.0 @ 24 oz/acre on 30 September 2022 and 20 October 2022, respectively; and Folex® 6 EC 16 oz/acre and Boll'd® 6SL 32 oz/acre on 17 October 2023] were applied to accelerate opening of matured unopened bolls and begin the defoliation process. Test plots were hand-harvested on 22 October 2020, 11-12 November 2021, 5 November 2022, and 2 November 2023. Hand-harvested yield samples were ginned, and the samples were analyzed for fiber quality parameters (HVI) at Cotton Incorporated.

Results and Discussion

2020 Study

Cotton fleahopper induced square injuries exerted very low level of square abscission (10-15%). Irrigation water level significantly influenced the cotton lint yield, as expected, with significantly higher yield with increased level of irrigation. Averaged across cotton fleahopper augmentation treatments, dryland produced the lowest lint yield (1102 lb/acre), followed by low water (1420 lb/acre), and the highest lint yield was observed under full irrigation (1691 lb/acre) (Fig. 1). Despite low insect injury, cotton fleahopper infestation at pre-squaring stage (before the onset of visible squares) reduced cotton lint yield across all three irrigation treatments, although the value was statistically significant only under dryland condition (Fig. 2). Even though not significant due to high data variation, lint yields were conspicuously reduced in both supplemental and full irrigation treatments when cotton fleahoppers were augmented at pre-square stage (Fig. 2). It is plausible that fleahoppers fed on growing terminals and likely damaged the invisible squares which ultimately reduced the lint yield. Also, cotton fleahopper infestations at early as well as late squaring (pre-flower) cotton did not reduce lint yield at any of the three irrigation regimes. Figure 2 suggests that cotton compensated or overcompensated (numerically) any fruit loss due to fleahopper-induced injury, ultimately showing no significant effect on lint yield. Early square stage of cotton appeared to be more susceptible to cotton fleahoppers than late squaring cotton under dryland condition; however, irrigated cotton did not show such differential responses. Manual removal of squares (100% squares removed at the time of first flower coinciding with the fleahopper infestation at late squaring stage) significantly reduced the lint yield under dryland condition, but plants compensated the manually removed fruit abscission under both irrigated conditions.

Cotton fleahopper infestation also impacted fiber quality while the plant response to cotton fleahopper injury was influenced by irrigation water level. High water treatment resulted in micronaire values in the premium range for all fleahopper augmentation sub-plot treatments (Fig. 3). Interestingly, lint fiber from the uninfested control plots had micronaire in the premium range, but the micronaire values increased and moved away from premium range to base range for all FH-augmented plots (Fig. 3). All sub-plot treatments resulted in micronaire values at base range under supplemental irrigation. Manual removal of squares resulted in premium micronaire value under dryland and base value under both irrigation regimes. Other fiber quality parameters varied marginally with insect augmentation X irrigation interactions (Table 1). These data clearly suggested an apparent interaction between fleahopper-induced injury to cotton and irrigation water availability for plants to overcome the injury effect, thereby influencing the lint yield and fiber quality.

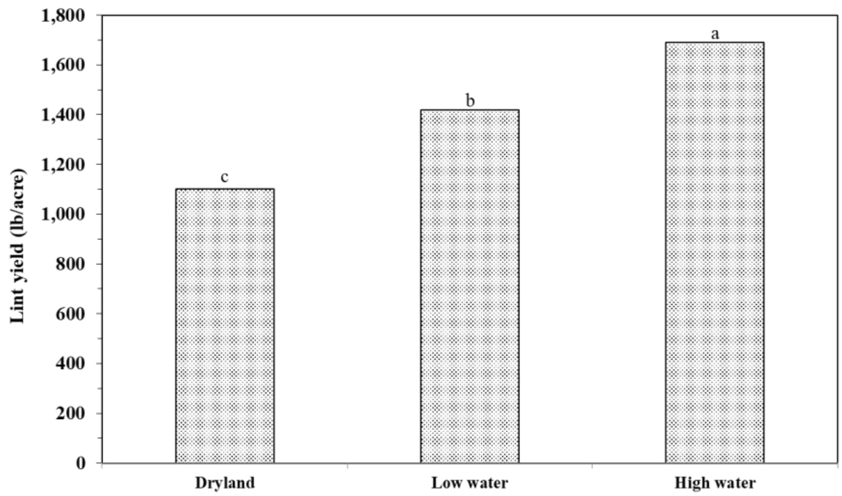

Fig. 1. Average cotton lint yield across cotton fleahopper augmentation treatments under three irrigation water regimes, Lubbock, Texas, 2020. Different lowercase letters indicate treatment means were significantly different from each other.

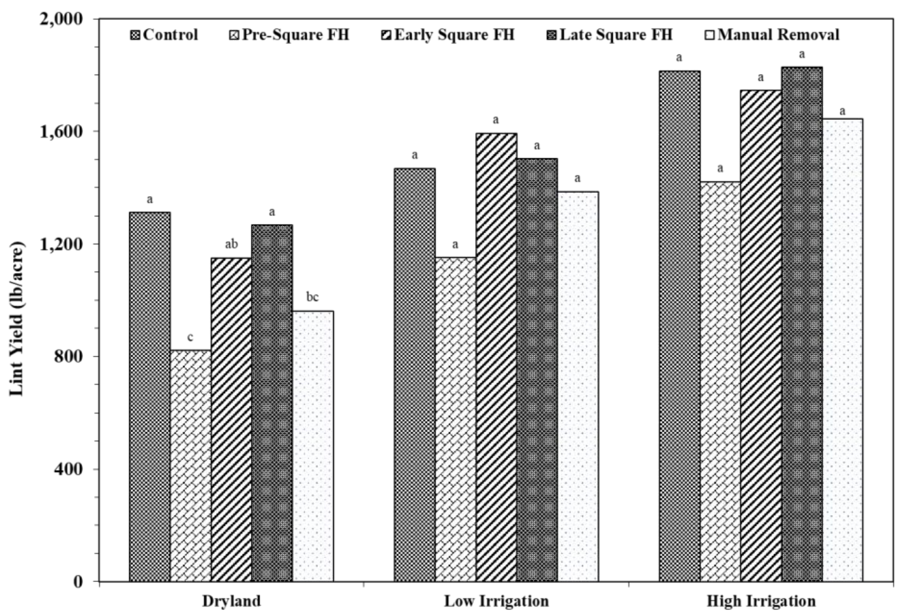

Fig. 2. Cotton lint yield following cotton fleahopper infestations at three cotton phenological stages and manual square removal at first flower under three irrigation water treatments, Lubbock, Texas, 2020. Average values were compared across five treatments within each irrigation treatment; same lowercase letters indicate treatment means were not significantly different from each other. Pre-square FH = fleahoppers augmented prior to the occurrence of visible squares in plants; Early square FH = fleahoppers released at 1-2 visible squares; Late square FH = fleahoppers released when cotton was about to begin flowering; Manual Removal = all visible squares removed from plants at first flower.

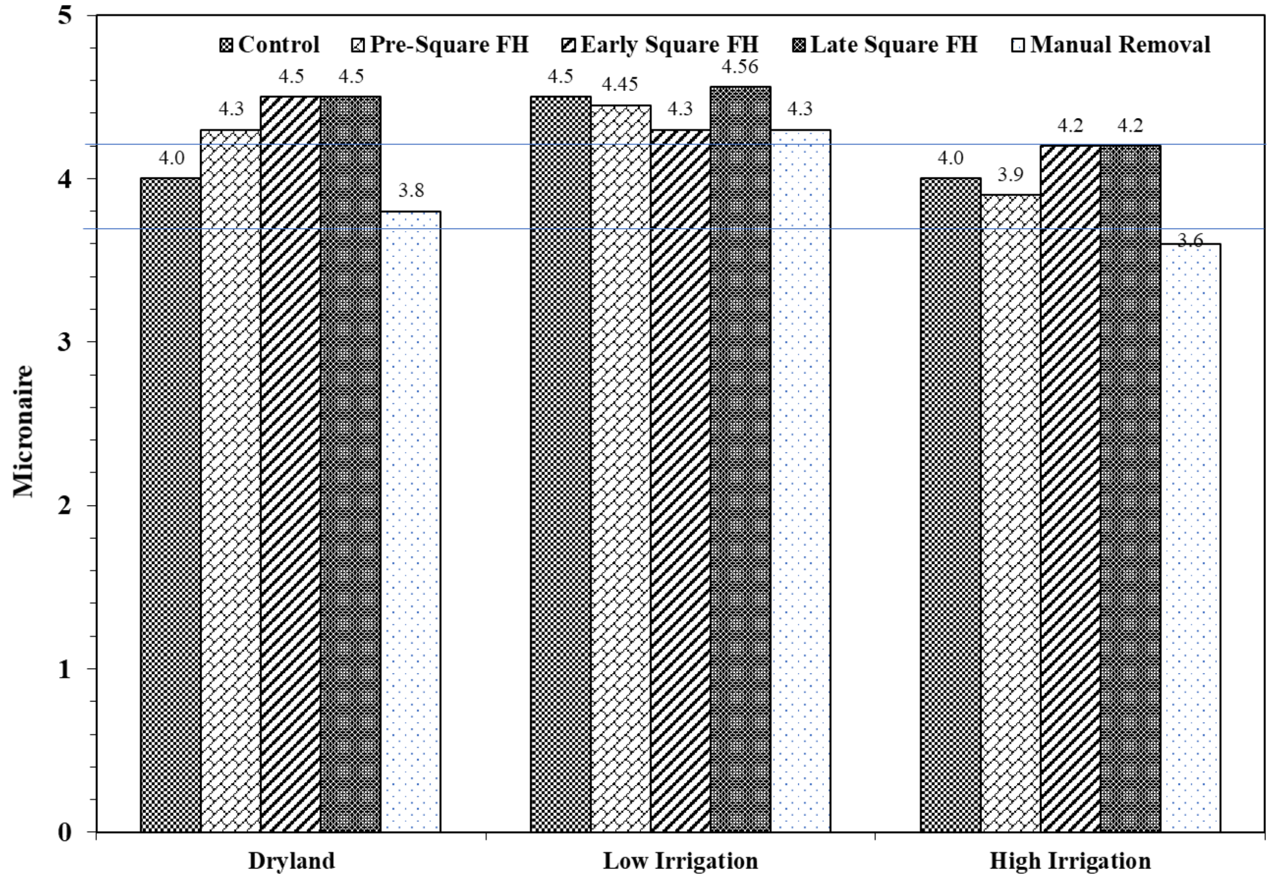

Fig. 3. Cotton fiber micronaire values (units) following cotton fleahopper infestations at three cotton phenological stages and manual square removal at first flower under three irrigation water treatments, Lubbock, Texas, 2020. Two blue lines indicate the region of micronaire values for the premium lint value. Pre-square FH = fleahoppers augmented prior to the occurrence of visible squares in plants; Early square FH = fleahoppers released at 1-2 visible squares; Late square FH = fleahoppers released when cotton was about to begin flowering; Manual Removal = all visible squares removed from plants at first flower.

Table 2. HVI fiber quality parameters influenced by cotton fleahopper augmentation treatments under three irrigation water treatments, Lubbock, Texas, 2020

Fiber Parameters	Irrigation Treatment	Fleahopper Simulation	Uninfested Control	Pre-Square Fleahopper	Early square Fleahopper	Late-square Fleahopper
Micronaire	Dryland	3.08	3.40	4.36	4.51	4.54
Fiber length	Dryland	1.10	1.13	1.14	1.16	1.14
Uniformity	Dryland	80.18	80.43	81.33	81.60	81.50
Strength	Dryland	30.95	31.80	32.13	32.35	32.30
Elongation	Dryland	7.73	7.68	7.65	7.83	7.73
Micronaire	Low	3.43	3.83	4.45	4.30	4.56
Fiber length	Low	1.15	1.16	1.14	1.16	1.16
Uniformity	Low	81.44	81.66	81.55	81.63	82.00
Strength	Low	31.91	31.60	31.88	32.00	31.93
Elongation	Low	7.84	7.99	7.73	7.93	7.85
Micronaire	High	3.00	3.39	3.93	4.24	4.22
Fiber length	High	1.17	1.17	1.20	1.21	1.20
Uniformity	High	80.73	80.94	82.08	82.23	82.60
Strength	High	31.61	31.71	32.15	31.78	31.00
Elongation	High	8.04	8.11	8.28	8.30	8.30

2021 Study

The effect of pre-square cotton fleahopper release was assessed when plants already had significant number of squares on the plant (10 days post-release) which showed 10% square loss, whereas early-square stage had 32% square loss and 21% square loss was observed at late-square stage. Flower initiation began around 7 August and continued beyond 10 September. Peak flower initiation was recorded on 26 August at all water level treatments; however, the highest number of flowers were recorded in dryland plots (Fig. 4) which was largely attributed to incessant rainfall during the cotton flowering stages that likely equalized all irrigation main treatment plots.

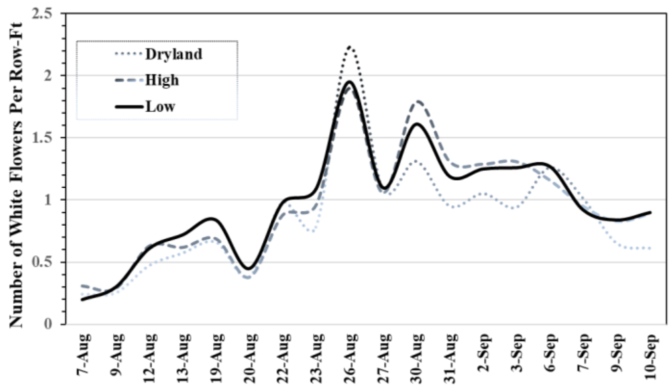

Figure 4. Temporal abundance of white flowers (number of white flowers per row-ft per sample date) recorded from cotton fleahopper infested plots under dryland versus irrigated production conditions, Lubbock, Texas, 2021.

Irrigation level did not significantly influence the lint yield. Replanting of the test delayed the crop maturity and reduced the overall yield. As stated previously, frequent rain events equalized the lint across three irrigation treatments (Fig. 5). Averaged across cotton fleahopper augmentation treatments, dryland produced 570 lb/acre, followed by 763 in low water and 697 in full irrigation treatments (Fig. 1). Insect release treatments significantly affected lint yield in dryland plots, with 627, 453, 793, and 407 lb/acre lint yield in uninfested control, thrips only, cotton fleahoppers only, and thrips+cotton fleahoppers plots, respectively. Even though thrips-induced damage was not apparent during the seedling stage, lint yield was dampened in thrips-release plots in dryland, albeit not statistically significant, and thrips+cotton fleahopper plots had significantly the lowest lint yield (Fig. 6) Lint yield did not vary amongst insect management treatments in low or high irrigation water treatments.

Cotton fleahopper infestation impacted fiber quality while the plant response to cotton fleahopper injury was influenced by irrigation water level (Fig. 7, Table 3). Micronaire values ranged from poor quality (<3.4) to premium (3.7-4.2) fiber across all three water treatments. Two insect-infested treatments in high water treatment had micronaire values in the premium range, but none on low water or dryland plots had micronaire in the premium range. There was no clear explanation for the observed variation in micronaire across treatments. Other fiber quality parameters varied marginally with insect augmentation X irrigation interactions (Table 3). These data suggested an apparent interaction between fleahopper-induced injury to cotton and irrigation water availability for plants to overcome the injury effect, thereby influencing the lint yield and fiber quality.

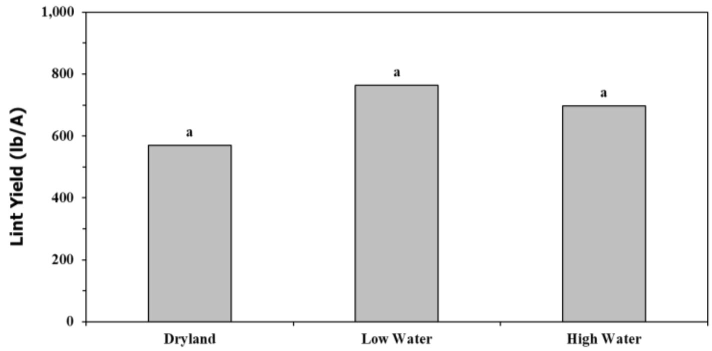

Figure 5. Average cotton lint yield across cotton fleahopper augmentation treatments under three irrigation water regimes, Lubbock, Texas, 2021. Same lowercase letter for each value indicates treatment means were not significantly different from each other.

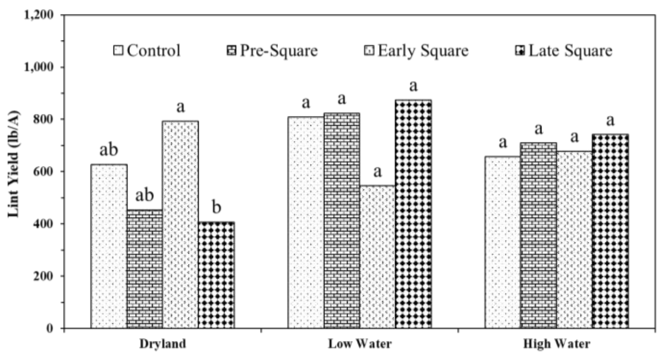

Figure 6. Cotton lint yield following cotton fleahopper infestations at three cotton phenological stages under three irrigation water treatments, Lubbock, Texas, 2021. Average values were compared across five treatments within each irrigation treatment; same lowercase letters indicate treatment means were not significantly different from each other.

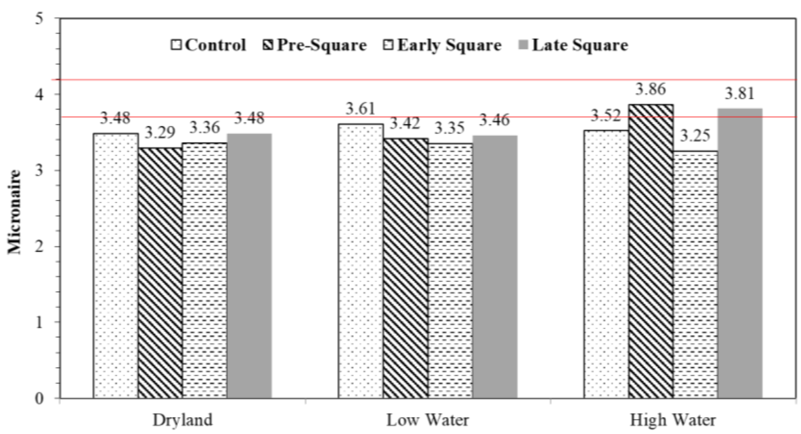

Figure 7. Cotton fiber micronaire (units) values influenced by cotton fleahopper infestation timing under three irrigation treatments, Lubbock, Texas, 2021.

Table 3. HVI fiber quality parameters influenced by cotton fleahopper augmentation treatments under three irrigation water treatments, Lubbock, Texas, 2021.

Parameters	Irrigation	Control	Pre-Square	Early Square	Late Square
Micronaire	Dryland	3.48	3.29	3.36	3.48
Fiber length	Dryland	1.15	1.17	1.18	1.18
Uniformity	Dryland	80.20	79.62	80.77	80.37
Strength	Dryland	31.67	32.07	32.77	31.65
Elongation	Dryland	7.20	7.27	7.37	7.42
Micronaire	Low	3.61	3.42	3.35	3.46
Fiber length	Low	1.16	1.17	1.18	1.16
Uniformity	Low	80.47	81.00	80.10	80.75
Strength	Low	31.42	32.30	32.82	32.52
Elongation	Low	7.75	7.80	7.60	7.47
Micronaire	High	3.52	3.86	3.25	3.81
Fiber length	High	1.19	1.18	1.16	1.18
Uniformity	High	81.20	80.70	80.47	81.95
Strength	High	32.82	30.45	31.77	32.57
Elongation	High	7.80	7.77	7.70	7.67

2022 Study

The effect of “pre-square” cotton fleahopper release was assessed two weeks after fleahoppers were augmented in test plots with no visible squares (squares were already forming but not visible), which showed 24% [18, 28, and 25% square loss, respectively, in dryland, supplemental irrigation, and full irrigation plots] square loss, whereas early-square stage had 17% square loss (19, 17, and 15% for dryland, supplemental, and full irrigation plots) and 20% square loss (22, 22, and 17% for dryland, supplemental, and full irrigation plots) was observed at late-square stage (Fig. 8).

Flower initiation began around mid-July and continued through late August. Peak flower initiation was recorded around 10 August at all water level treatments (Fig. 9). Flowering dynamics were significantly altered by cotton fleahopper infestations. Uninfested control plots had much higher flower densities in irrigated treatment plots compared to that in dryland plots, whereas flower densities were dampened, and flowering profiles altered when cotton fleahopper infestations occurred. Interestingly, cotton fleahopper infestations at pre-square stage of cotton, while the flowering dynamics were altered, did not significantly reduce the total flower densities while delaying the major flower activity. It suggests that the cotton fleahopper infestation in pre-squaring cotton will likely damage the plant terminal along with developing squares that are not yet visible, thereby delaying the plant's reproductive growth.

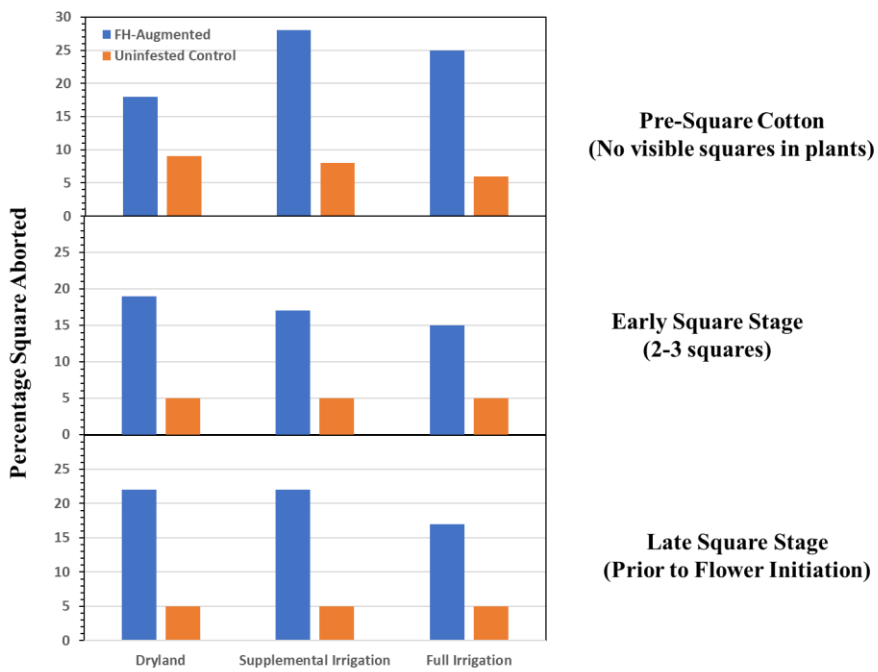

Figure 8. Average percentage square aborted during pre-, early, and late square stages of pre-flower cotton under dryland versus irrigated production conditions, Lubbock, Texas, 2022.

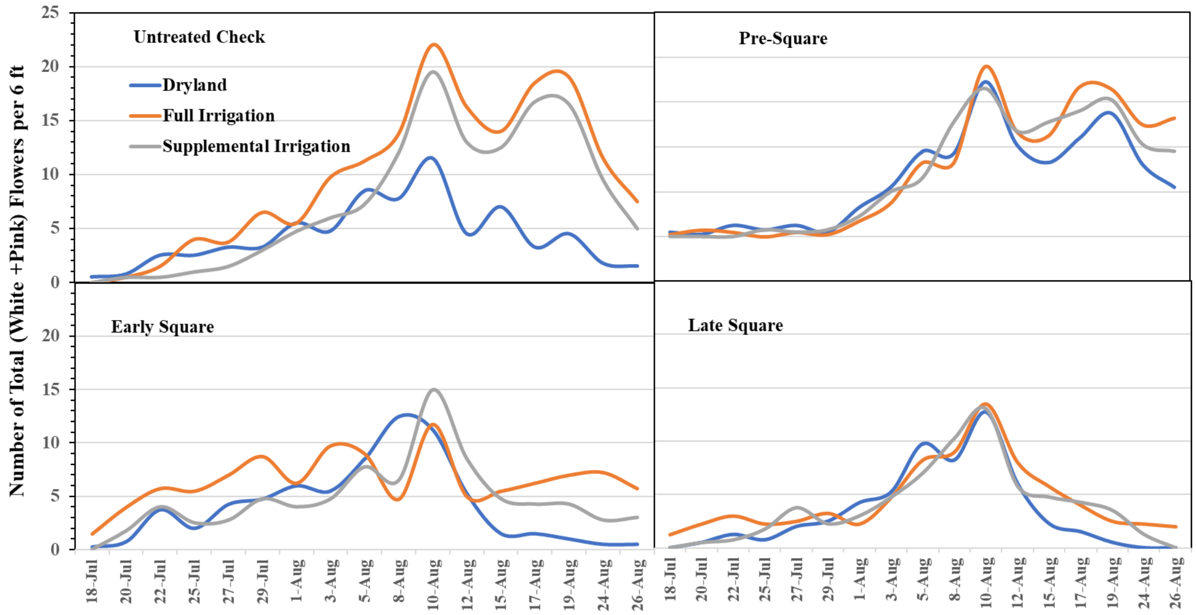

Figure 9. Temporal abundance of white+pink flowers (number of total flowers per 6 row-ft per sample date) recorded from cotton fleahopper infested plots under dryland versus irrigated production conditions, Lubbock, Texas, 2022.

Lint yield did not significantly vary across irrigation treatments due to unusually hot and dry growing conditions. Nevertheless, fleahopper infestations during pre-square stage reduced yield in both dryland and full irrigation regimes, whereas cotton fleahopper infestations at late squaring stage drastically reduced yield under dryland conditions (Fig. 10). Cotton fleahopper infestations also impacted fiber quality parameters (Table 4).

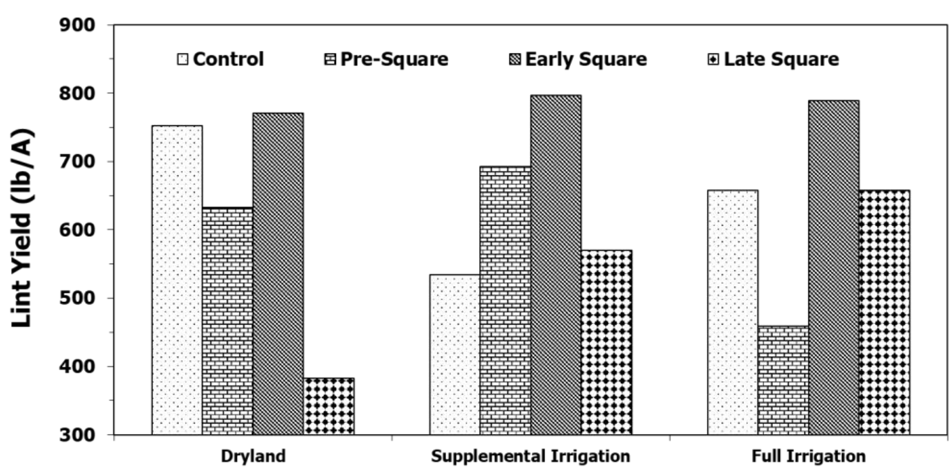

Figure 10. Cotton lint yield following cotton fleahopper infestations at three cotton phenological stages under three irrigation water treatments, Lubbock, Texas, 2022.

Table 4. HVI fiber quality parameters influenced by cotton fleahopper augmentation treatments under three irrigation water treatments, Lubbock, Texas, 2022.

Parameters	Irrigation	Control	Pre-Square	Early Square	Late Square
Micronaire	Dryland	4.49	4.31	4.37	4.67
Fiber length	Dryland	1.16	1.13	1.13	1.15
Uniformity	Dryland	81.80	80.55	80.90	81.10
Strength	Dryland	28.35	29.20	29.65	29.93
Elongation	Dryland	7.56	6.90	6.98	6.95
SFC	Dryland	9.10	10.23	10.03	9.28
Micronaire	Low	4.96	4.80	4.59	4.12
Fiber length	Low	1.13	1.14	1.15	1.12
Uniformity	Low	81.80	80.55	81.55	80.08
Strength	Low	30.28	30.10	29.30	29.00
Elongation	Low	6.75	6.45	6.90	6.50
SFC	Low	9.18	9.63	9.38	11.48
Micronaire	High	4.53	4.10	5.34	4.67
Fiber length	High	1.18	1.14	1.09	1.09
Uniformity	High	81.60	80.18	81.10	79.75
Strength	High	31.03	28.25	30.30	28.38
Elongation	High	6.63	7.05	6.30	6.40
SFC	High	9.53	11.08	9.78	11.53

2023 Study

The effect of “pre-square” cotton fleahopper release was assessed two weeks after cotton fleahoppers were augmented in test plots with no visible squares (squares were already forming but not visible), which showed 34.3% [35, 32, and 36% square loss, respectively, in dryland, supplemental irrigation, and full irrigation plots] square loss, whereas early-square stage had 29.3% square loss (25, 31, and 32% for dryland, supplemental, and full irrigation plots) and 29.3% square loss (27, 30, and 31% for dryland, supplemental, and full irrigation plots) was observed in late-square stage cotton (Fig. 11).

Flower initiation began around mid-July and continued through late August. Flowering profile was monitored from 23 July until 1 September (Fig. 12). Cotton fleahopper infestation significantly altered the flowering dynamics of cotton. In uninfested control plots, full irrigation resulted in higher flower densities compared to that in supplemental irrigation and dryland regimes. On the other hand, cotton fleahopper infestations during pre-squaring stage delayed flowering where most of the major flowering activity occurred after mid-August. The early and late square stage infestations did not particularly delay flowering, but the flowering patterns were altered (Fig. 12).

Total flower abundance varied with an interactive effect of irrigation water and cotton fleahopper infestation. Under dryland condition, cotton fleahopper induced square loss resulted in plant’s compensatory growth and increased flower production, with significantly greater abundance of total flowers in cotton fleahopper infested plots compared to that in uninfested plots (Fig. 13). However, the effect was inconsistent under irrigated conditions. Pre-square infestation increased flower densities under supplemental irrigation while the early and late square infestations did not have measurable effect on total flower abundance under supplemental irrigation. Under full irrigation, cotton fleahopper induced square loss reduced total flower abundance marginally (early squaring) or significantly (pre- and late squaring) (Fig. 13).

The total flower densities strongly correlated with lint yield (correlation coefficient= 0.676). The predictive relationship between total flower densities and lint yield was described by a linear equation, $Y = 0.002021 * F - -45.8849$, where Y = lint yield (lb/acre), F = total white flowers per acre from flower initiation until crop cut-out. Lint yield was uncharacteristically low in 2023 due to harsh early growing conditions and severe drought later in the season. Nevertheless, the average lint yield, combined across the insect augmentation treatments, increased with the level of irrigation water availability (Fig. 14). Dryland, supplemental irrigation and full irrigation produced 276, 496, and 587 lb/acre lint, respectively. At low production situation, dryland and supplemental irrigation either compensated or overcompensated the cotton fleahopper induced early fruit loss, whereas cotton fleahopper reduced yield at full irrigation production regime (Fig. 14).

Averaged over a 4-year period, our study demonstrated that the cotton fleahopper induced square loss caused more severe impact on dryland and high irrigation/high input production systems compared to that in low input/deficit irrigation systems (Figs. 15-16). Overall, cotton fleahoppers reduced 96 lb/acre lint yield compared to uninfested control plots in dryland scenario. However, plants compensated for the square loss under supplemental irrigation and increased yield by 63 lb/acre, whereas cotton fleahopper reduced 67 lb/acre lint yield under full irrigation production (Fig. 16). A strong interaction existed between irrigation water regime and cotton fleahopper infestation timing in impacting cotton’s ability to compensate for the pre-flower fruit loss.

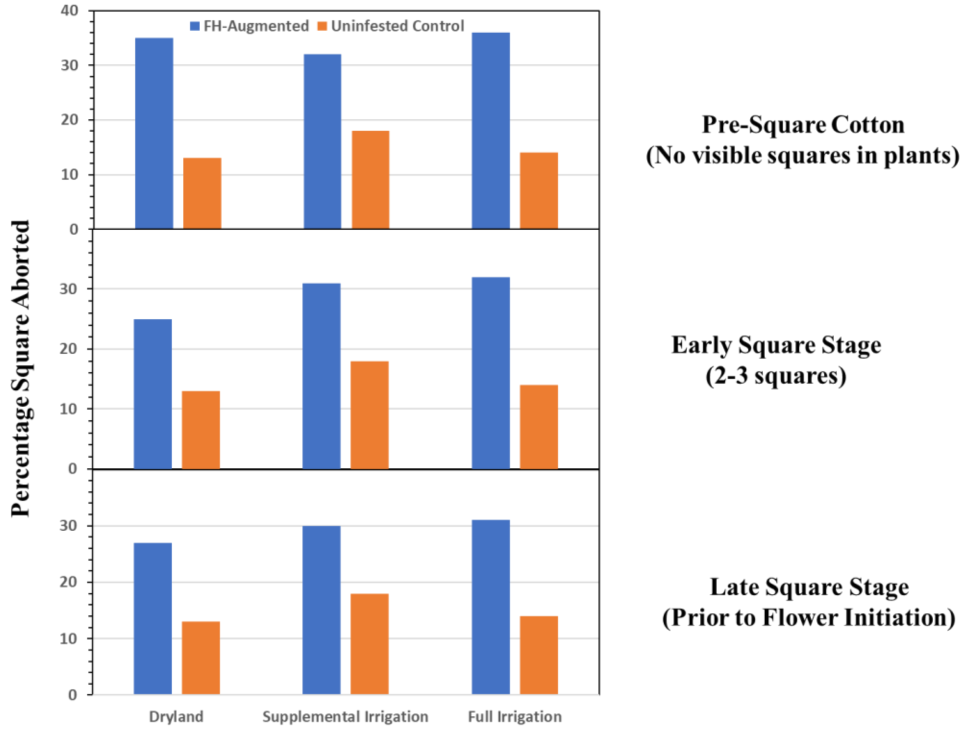

Figure 11. Average percentage square aborted during pre-, early, and late square stages of pre-flower cotton under dryland versus irrigated production conditions, Lubbock, Texas, 2023.

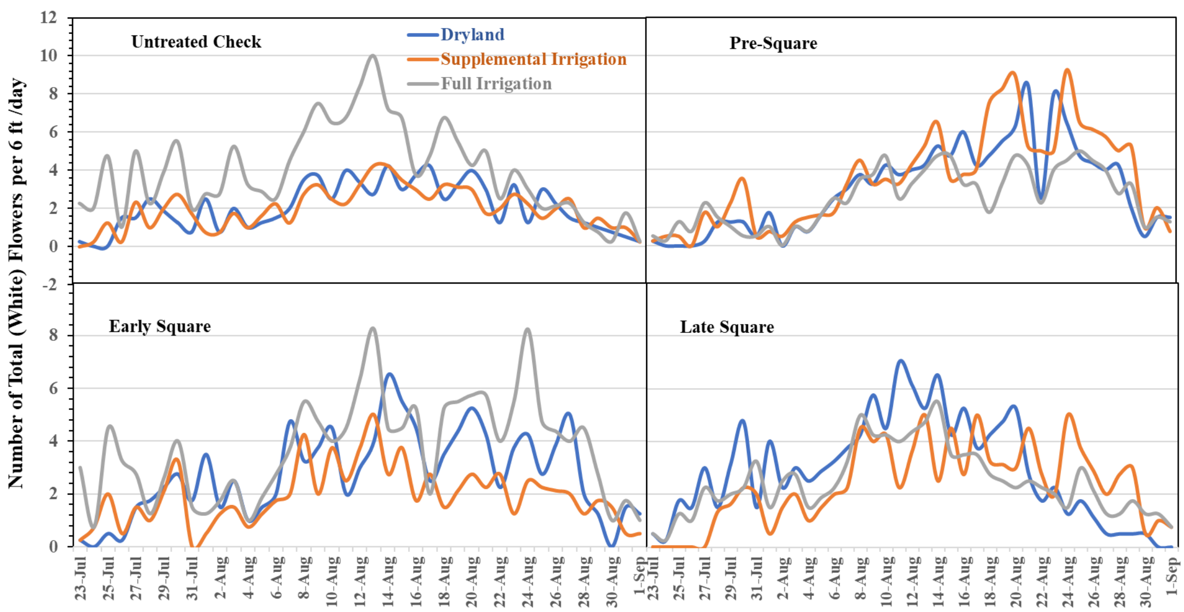

Figure 12. Temporal abundance of white flowers (number of total flowers per 6 row-ft per day) recorded from cotton plots receiving cotton fleahopper infestations at three phenological stages of pre-flowering cotton (pre-squaring, early squaring and late squaring) versus control plots under three irrigation regimes, Lubbock, Texas, 2023.

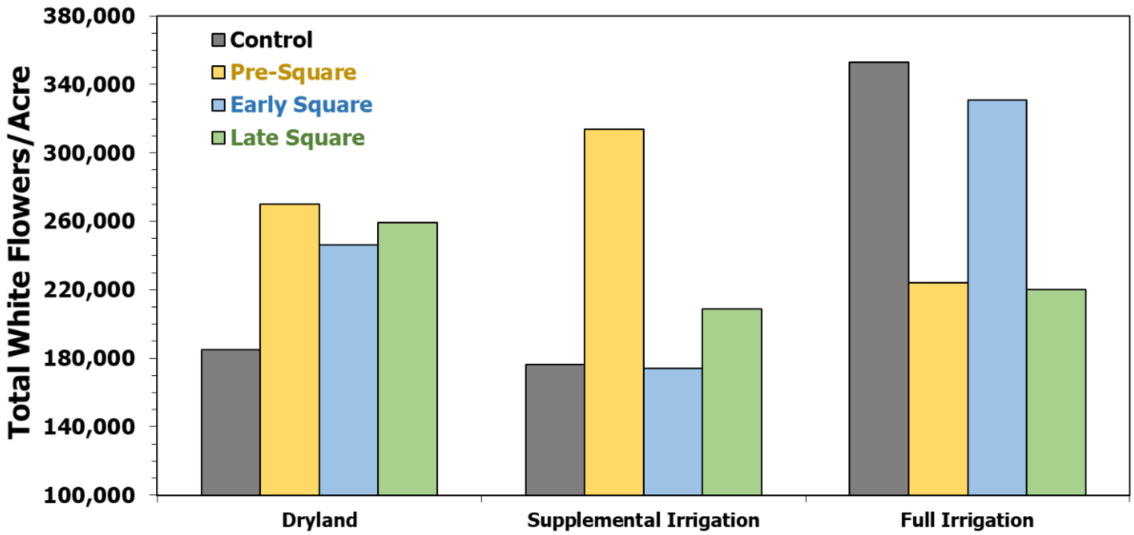

Figure 13. Total abundance of white flowers (number of total flowers per acre) recorded from cotton plots receiving fleahopper infestation at three phenological stages of pre-flowering cotton (pre-squaring, early squaring and late squaring) versus control plots under three irrigation regimes, Lubbock, Texas, 2023.

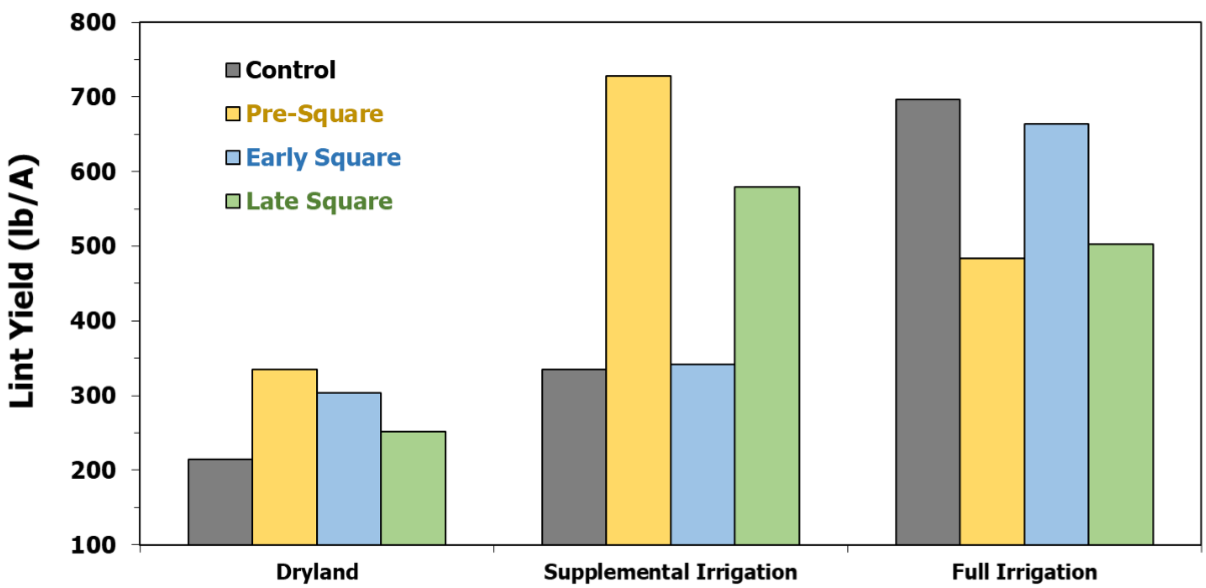

Figure 14. Cotton lint yield following cotton fleahopper infestations at three cotton phenological stages under three irrigation water treatments, Lubbock, Texas, 2023.

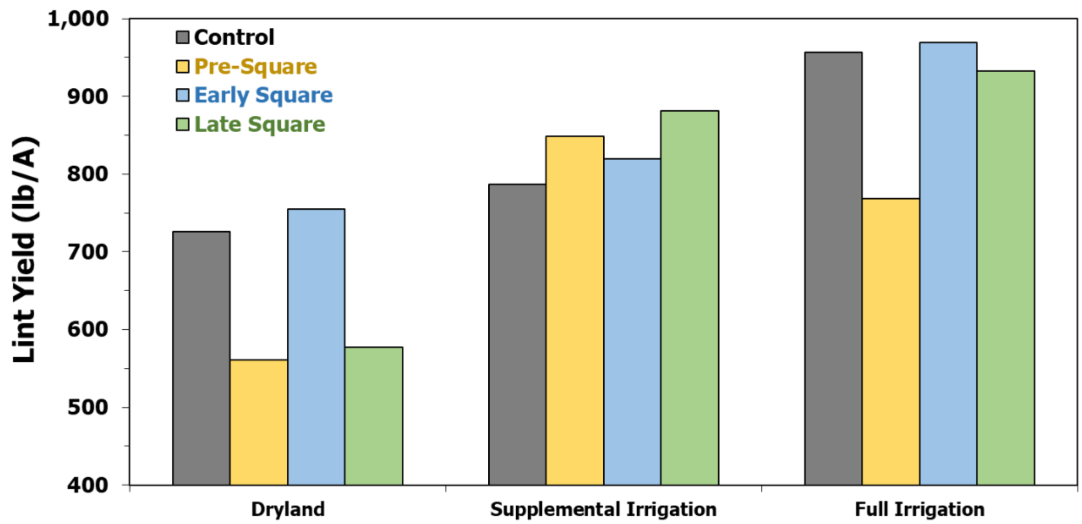

Figure 15. Four-year average cotton lint yield following cotton fleahopper infestations at three cotton phenological stages under three irrigation water treatments, Lubbock, Texas, 2020-2023.

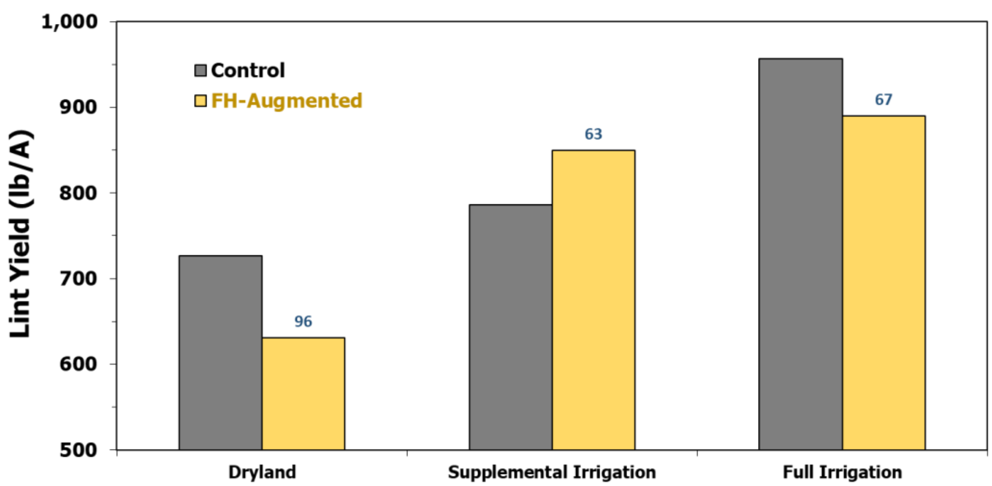

Figure 16. Impact of cotton fleahopper induced square loss on cotton lint yield under three irrigation water treatments, Lubbock, Texas, 2020-2023.

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Cover crop and insect-pest management in water-deficit cotton production

Cotton Incorporated - Texas State Support Committee

Project Number: 23-943TX
PI: Megha N. Parajulee
CO-PIs: Wayne Keeling, Suhas Vyavhare, and Donna McCallister

PROJECT SUMMARY

The Texas High Plains (THP) is a semi-arid region with characteristic low rainfall, with production agriculture supported by limited irrigation or solely rain-fed. As a result, the cropping system in this region is largely low-input, and the producer decision-making in economically profitable input use is a challenge. Recurring drought conditions have disproportionately depleted the underground water, significantly shifting the cotton production outlook in THP to even lower input with dryland acreage reaching 60-65%. The intrinsic value of cover crops in THP cotton production system has been well established, including soil conservation, early-season seedling protection from wind, and improved soil health. However, the use of cover crops has not been fully utilized, especially for the lack of sufficient information on the amount of water required to grow cover crops versus the value of terminated cover crop in decreasing evaporation from the soil surface, increased infiltration of rainwater and moisture storage, and increased water use efficiency. Also, the value of cover crop on insect management, particularly thrips population dynamics and the resulting effect on early crop vigor, needs to be examined to ensure that the effectiveness of the cover crop is maximized across various production options.

The objectives of this project are to: 1) quantify the impact of cover crops on early seedling growth and cotton susceptibility to thrips infestations across three irrigation water availability, 2) evaluate the interactive effect of cover crop, seedling vigor, and thrips infestations on cotton yield and fiber quality, and 3) develop a dynamic optimization economic model that maximizes the net returns from management of cover crops and thrips under water-deficit crop production conditions.

Two cover crops (rye and wheat) and a control (no cover crop) were deployed under three irrigation treatments (full irrigation, supplemental irrigation, and dryland). Cover crops were planted in early spring and terminated in late spring to ensure that they were at proper height but before heading for the best performance. Two thrips infestation treatments (thrips augmented versus spray-control) were deployed within each of the 9 main plot treatments (3 water levels x 3 cover crops x 2 thrips treatments = 18 treatment units), replicated four times (72 plots). Terminated rye and wheat cover did not significantly influence thrips colonization and the thrips densities were much below economic thresholds. Irrigation and cover crops significantly influenced the cotton flowering patterns. Full irrigation produced the highest abundance of white flowers, followed by supplemental irrigation plots, and the lowest flower abundance was observed in dryland. Cover crops resulted in higher flower densities than no-cover (fallow) plots. In-season plant parameters such as plant height and flowering patterns and flower densities correlated with lint yield, with highest lint yield under full irrigation, followed by supplemental irrigation, and the lowest yield in dryland. The interaction of irrigation and cover crop treatments influenced the lint yield. Cover crops produced marginally higher yield in dryland compared to fallow plots, whereas fallow plots produced higher yield than cover crop plots under high irrigation. Thrips augmentation had no effect on lint yield.

Cover crop and insect-pest management in water-deficit cotton production

INTRODUCTION

The Texas High Plains (THP) is a semi-arid region with characteristic low rainfall (average annual rainfall of 15-18 in.), with production agriculture supported by limited irrigation or rain-fed. As a result, the cropping system in this region is largely low-input and the producer decision-making in economically profitable input use is a challenge. THP has been facing some significant drought conditions in recent years, including the historic drought of 2011 that claimed much of the Texas production agriculture, reducing total cotton yield that year by 55%. Drought is a recurring issue for THP agriculture which has disproportionately depleted the underground water, significantly shifting the cotton production outlook to even lower input with dryland acreage reaching upward of 60%. The shift in cotton production system due to devastating droughts in an already semi-arid region has altered our input resources, cultivars, and management practices. Low cotton market price, increased fertilizer price, and reduced water availability have forced farmers to move toward reorganizing available input resources to sustain their production enterprise. While the drought and heat conditions are unpredictable, the anticipated changes in global climate patterns may exacerbate the water-deficit conditions further in THP. Thus, transitioning to the new crop production reality via developing economic data-based input management practices has become our priority to sustain producer profitability and for future success of the U.S. cotton industry.

In agricultural systems, vegetation structure associated with different agronomic practices may have potential implication for insect predation and natural pest suppression. Habitat management provides food for prey and shelter for adverse conditions which favors natural enemies and enhances biological control. Generally, cover crops provide refuge to beneficial insects. We have demonstrated at AGCARES research that the no-till cover crop system harbored twice the density of predatory arthropods in cotton than no-cover conventional tillage system. No-tillage plots and organically managed crops tend to have higher diversity of beneficial insects than non-organic crops and tillage plots. Long-term research at AGCARES farm has also shown that soil organic carbon was greatest in the no-tillage with cover crops at the 0-6" depth compared to the conventional tillage treatments prior to planting cotton. Profile soil water was greatest following the no-tillage cover cropping systems compared to the conventionally grown system. During the cropping season, soil moisture was greatest in the no-till treatments where greater soil cover provided by cover crop residue likely increased water capture and reduced evaporation losses. Organic matter and reduced tillage can improve soil structure increasing infiltration and percolation while decreasing evaporation from the soil surface. The no-till treatments were better able to respond to precipitation events possibly through increased infiltration and moisture storage.

Because limited information is available on the impact of cover crops on population abundance and diversity of arthropod natural enemies, especially across the range of irrigation water regimes, and on the value of terminated cover crop in enhancing seedling vigor and its tolerance to thrips injury, this project aimed to characterize the impact of cover crops x thrips infestation x irrigation water levels on crop health, soil health, and cotton yield and fiber quality and develop a dynamic economic model to determine the suitability of cover crops for the range of irrigation regimes in Texas High Plains cotton.

Predicting pest populations under different water-deficit crop production scenarios and understanding how these conditions influence pest populations to impact crop production risks, are critically important components for implementing pest management strategies as crop cultivars and other input variables continue to change. Reduced water availability, low rainfall, higher pumping cost of limited water, and increased input cost may result in lower yields and correspondingly lower profit margins, warranting for higher water use efficiency in our crop production. The use of cover crops has not been fully utilized in Texas High Plain cotton, especially for the lack of sufficient information on the amount of water required to grow cover crops versus value of terminated cover crop in decreasing evaporation from the soil surface, increased infiltration of rainwater and moisture storage, and increased water use efficiency. Therefore, cotton producers must carefully consider cost-benefit of cover crops across the range of water availability and its value to early seedling health and thrips population dynamics, in-season crop growth and earliness, and yield and fiber quality for overall net profit margin. The objectives of this study were to: 1) Quantify the impact of terminated cover crops on cotton germination, seedling growth and cotton tolerance to thrips infestations across three irrigation water availability, 2) Evaluate the interactive effect of cover crop, seedling vigor, and thrips infestations on cotton yield and fiber quality, and 3) Develop a dynamic optimization economic model that maximizes the net returns from management of cover crops and thrips under water-deficit crop production conditions.

METHODOLOGY

A field study was conducted at Texas A&M AgriLife Research site in Lubbock, Texas. The study consisted of two cover crops (rye and wheat) and a control (no cover crop) deployed under three irrigation treatments (full irrigation or high irrigation, supplemental irrigation or low irrigation, and dryland) and two thrips infestation treatments (thrips augmented versus spray-control) then deployed within each of the nine main plot treatments (3 cover crop x 3 irrigation), replicated four times (total 72 experimental plots). Three irrigation water levels (near-dryland, limited irrigation or 30% ET replenishment, and full irrigation or 90% ET replenishment) achieved through subsurface drip irrigation simulated three water-deficit production conditions, including high (near-dryland condition), medium, and no water deficits (full irrigation). Two cover crops (rye and wheat) and a control (no cover crop) were sown on 8 February 2023 under each of the three irrigation treatments (full irrigation, supplemental irrigation, and dryland). Cover crop planting was timed to ensure a reasonable height and biomass but before heading for the best performance (sufficient biomass but tolerance to lodging) by the time cotton was planted in mid-May. Cotton cultivar DP2020B3XF was planted on May 18, but the crop germination was delayed, and the plant stand was compromised due to rain/hail event.

Thrips treatments and sampling. On 6 June 2023, two thrips infestation treatments (thrips augmented versus spray-control) were deployed within each of the 9 main plot treatments (3 water level x 3 cover crop x 2 thrips treatments = 18 treatment units), each treatment replicated four times (total 72 plots). Thrips sampling was done in all treatment plots on 6 June 2023. Natural colonization of thrips was expected to achieve threshold densities, but the actual densities were much lower than thrips thresholds (1 thrips per leaf). Thus, thrips were augmented on 7 June 2023 in all thrips-designated plots by placing excised alfalfa terminals with thrips at the base of the cotton seedlings to ensure a significant pest pressure in these plots and to achieve quantifiable infestations and seedling damage. No-thrips plots were kept insect-free via insecticide sprays. Thrips sampling was done again on 12 June and 19 June. Thrips damage ratings were done on 9, 20 and 26 June. Plant heights were taken at 1-week intervals on 3, 10, 17, 24, and 31 July and 7, 14, 21, and 28 August (9 sample dates).

Cotton flower monitoring (number of white flowers counted per 6-ft section treatment rows) was done for 18 sample dates, at 2-3 days intervals. Actual flower monitoring dates were 24, 26, 28, and 31 July, 2, 4, 7, 9, 11, 14, 16, 18, 21, 23, 25, 28, and 30 August, and 1 September 2023. Approximately 1-inch diameter size bolls (20 per plot) were collected from irrigation main-plot treatments at crop cut-out and measured for individual boll size, weight, and the pressure required to puncture the carpel wall of the boll using a penetrometer to determine the boll susceptibility to insect feeding as affected by irrigation treatments. Harvest-aid (a tank mix of Folex® 6 EC 16 oz/acre and Boll'd® 6SL 32 oz/acre) was applied on October 17 to terminate the crop. Test plots were hand-harvested on 2 November 2023. Hand-harvested yield samples were ginned, and the samples have been sent to Cotton Incorporated for fiber analysis (HVI parameters).

RESULTS

Harsh weather (excessive rain and sandstorms) during early season and extreme drought during the reproductive phase of cotton resulted in uncharacteristically low yield across all treatments in 2023. Thrips colonization was insignificant even with the augmentation of thrips during the seedling stage. Thrips densities remained <1 thrips per plant during the first four weeks of cotton growth stage. Thrips injury ranking was 1-3 (injury ranking at 1 to 5 scale where 1 is cosmetic damage and 5 is plant terminal is completely dead) during the first 2-true leaf stage and 2-3 at 5-6 true-leaf stage. While not significant, dryland plots received more thrips injury compared to that on irrigated plots.

Plant growth was significantly influenced by irrigation treatment. Plants were taller in high irrigation plots throughout the growing season compared to that in dryland. While low irrigation plots had numerically shorter plants than in high irrigation plots, the heights between the two water treatments were not significant (Fig. 1). Cover crops did not significantly affect the plant height. Similarly, thrips augmentation did not impact on plant height. Because thrips densities were much below economic threshold, the injury they exerted was not expected to influence the plant height.

Irrigation treatments significantly impacted the flowering dynamics. The high irrigation plots began flowering earlier and greater number of flowers were observed in high irrigation plots until peak flowering stage (about second week of August). Flower initiation was delayed in dryland plots and the flower densities were the lowest of three irrigation treatments until crop reached the peak flowering stage (Fig. 2). Cover crops also influenced flowering patterns with fallow plots producing the lowest densities of flowers until the crop reached peak flowering stage and then the fallow plots produced the highest numbers (Fig. 2). This type of flowering pattern is a clear indicative of a lag in growth and reproductive phenology in fallow plots compared to that in terminated cover crop plots. While thrips densities and injury ratings were low, thrips augmentation plots showed slightly lower flower densities compared to no-thrips control plots.

As stated earlier, lint yields were low in 2023 and the variability in data was too high. Nevertheless, irrigation treatments showed a staircase effect on yield with increased lint yield for increased level of irrigation. On average, dryland, low irrigation and high irrigation plots produced 250, 511, and 626 lb/A lint, respectively (Fig. 3). The interaction of irrigation and cover crop treatments influenced the lint yield. Cover crops produced marginally higher yield in dryland compared to fallow plots, whereas fallow plots produced higher yield than cover crop plots under high irrigation. Thrips augmentation had no effect on lint yield.

This is the first year of the project and the data were somewhat encouraging in that there existed irrigation x cover crop interaction in influencing plant growth, fruiting profile, and lint yield. We expect to repeat this study for at least two more years to capture year-to-year variability in data.

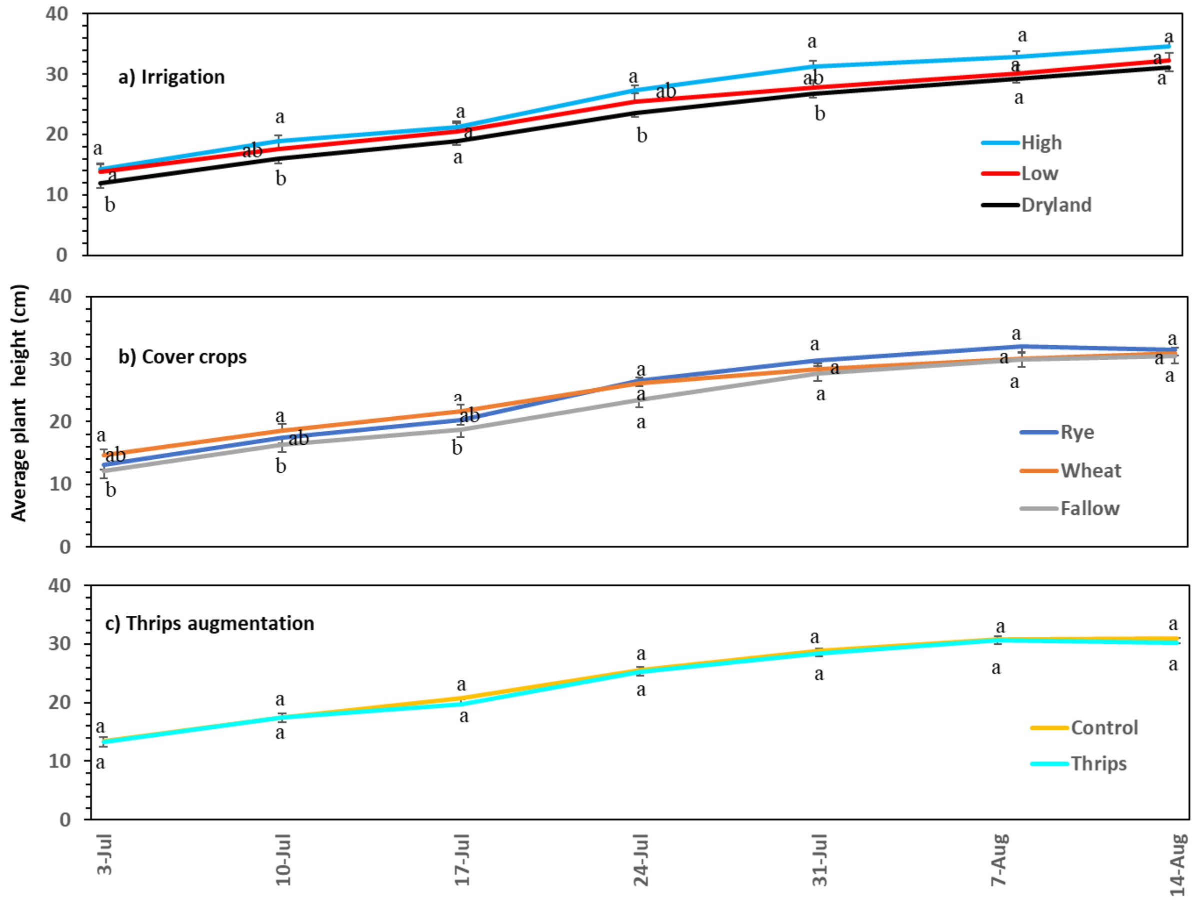

Figure 1. Temporal change in plant height (cm) as influenced by irrigation level, cover crop type, and thrips augmentation treatment ($p < 0.1$, LSD test), 2023.

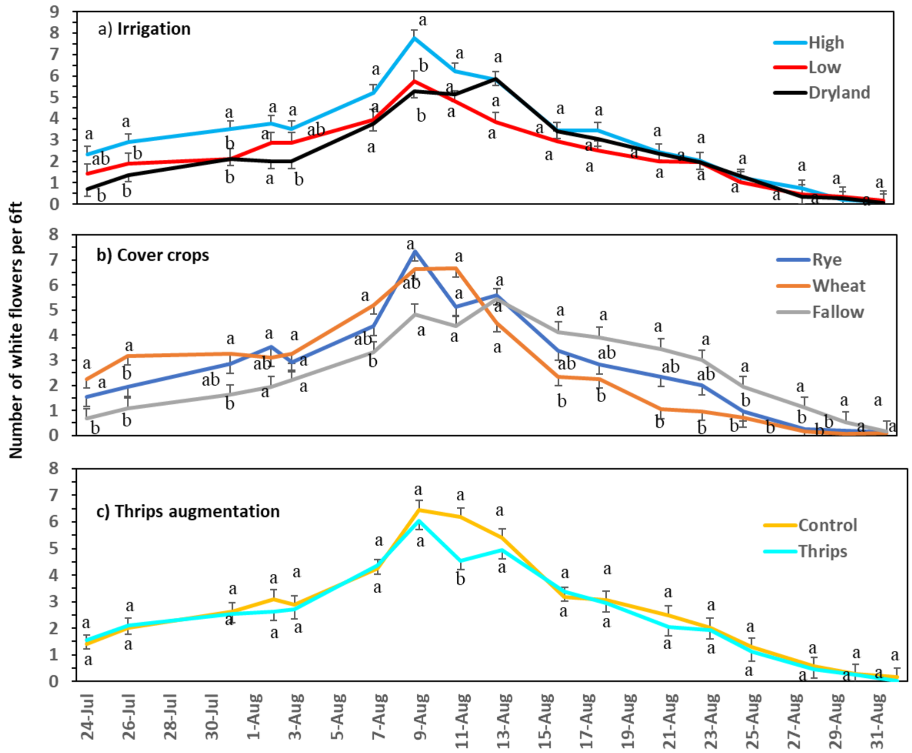

Figure 2. Average number of white flowers per 6-ft per sample date in cotton as influenced by irrigation level, cover crop type, and thrips augmentation treatment. Bars on the means are standard errors. Bars with different letters indicate a significant difference between treatments ($p < 0.05$, LSD test).

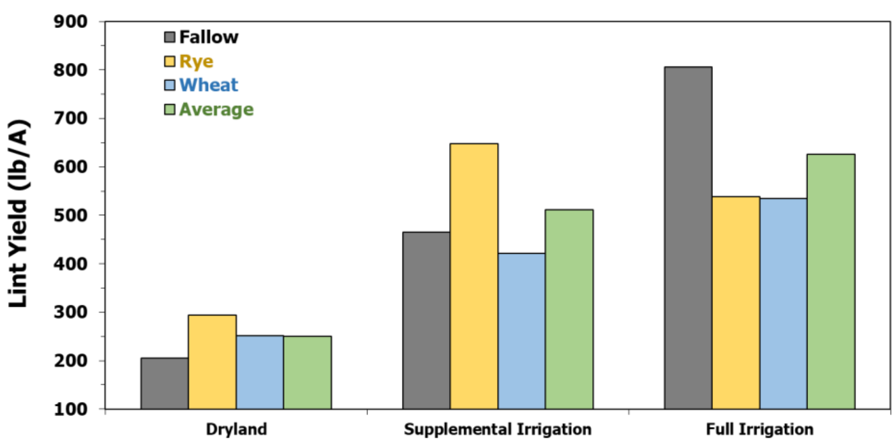

Figure 3. Average cotton lint yield (lb/A) as influenced by irrigation level and cover crop types, Lubbock, TX, 2023.

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