DETERMINATION OF PHYSIOLOGICAL "CUT-OUT" IN LOUISIANA COTTON BASED UPON NODES ABOVE WHITE FLOWER

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Abstract

Six tests were conducted during the two-year period, 1998 to1999, to determine the physiological "cut-out" stage of cotton within Louisiana's environment. Nodes above white flower (NAWF) plant growth stages were used to monitor crop development. Seedcotton yields were harvested from an upper and lower zone of plants divided at target stages of NAWF 5-6, NAWF 4-5, NAWF 3-4, and NAWF 2-3. Plants within those target stages remained non-damaged had complete square removal in the upper zone, or had the main-stem terminal severed between the two harvested zones. In general, these data show yields in the upper harvested zones for NAWF 5 and NAWF 4 target stages contribute significantly to yield depending on the level of square loss in the upper zone. Yield compensation by bolls in the lower zone for square loss in the upper harvested zone was a significant factor in these experiments.

Introduction

The need to develop a more effective method to terminate late-season insecticide treatments has been a critical issue for many researchers. A quantitative procedure that would accurately estimate the time to properly terminate late-season insect management without the risk of economic loss by insects would have numerous advantages to producers. This same information would enable producers to properly apply harvest-aid products without deleterious effects on yield and lint quality. Reducing insecticide application frequency, especially during the late-season, would reduce selection pressure on many insect pests. The most costly insecticide treatments with the least selectivity are used during the late-season against high densities of insect pests. Furthermore, producers could reduce production costs and eliminate exposure of non-target organisms with proper termination of late-season insecticide use.

Recent research in Arkansas has suggested that physiological "cut-out" is defined as that plant development stage when the number of main-stem nodes above the uppermost white flower (NAWF) is ≤ 5 (Bourland et al. 1992, Oosterhuis et al. 1993). Information on when the harvestable crop is set on the plant and when no additional fruit development will contribute to yield is the basis for estimating when the harvestable crop is safe from insect injury and insect pest control is no longer needed. Research in Arkansas has shown that fruiting forms produced on main-stem nodes above the NAWF 5 stage did not contribute significantly to total yield (Bourland et al. 1992). This method of quantifying crop physiological "cut-out" and a basis for termination of late-season insect pest control strategies without yield loss has been based effectively in Arkansas and Mississippi cotton fields, but has been inconsistent in Louisiana. The objective of this study is to define the proper NAWF plant stage that corresponds to physiological "cut-out" within Louisiana's environmental conditions.

Materials and Methods

Six field experiments were done during the two-year period, 1998 to 1999, at selected research stations in Louisiana. Cotton (cv. Sure-Grow 821, Sure-Grow Seed, Inc., Centre, AL 35960) was planted on 29 May 1998 and 13 May 1999 at the Macon Ridge Location of the Northeast Research Station near Winnsboro, LA. Transgenic *Bacillus thuringiensis* Kurstaki (Bt) cotton (cv. NuCOTN 33^{B}, Delta and Pine Land Co., Scott, MS 38772) containing the Bollgard® gene (Monsanto Co., St. Louis, MO 63167) was planted 6 May 1998 and 3 May 1999 at the Macon Ridge Station. Cotton (cv. NuCOTN 33^{B}) was planted on 13 May at the Dean Lee Research Station near Alexandria, LA. Stoneville 474 (Stoneville Pedigree Seed Co., Memphis, TN 38115) cottonseed was planted on 17 May 1999 at the Red River Research Station near Bossier, LA. Stoneville BXN 47 (Stoneville Pedigree Seed Co., Memphis, TN 38115) seed was planted 20 Apr 1999 at the Northeast Research Station near St. Joseph, LA, respectively. The 1998 and 1999 tests at the Macon Ridge Station were irrigated with an overhead lateral-move sprinkler system. Fertilization rates and general agronomic practices recommended by the Louisiana Cooperative Extension Service were used to maintain uniformity of all plots across all tests. Injury from native insect pest infestations was suppressed with weekly applications of insecticides at the recommended rates prescribed in the Louisiana Insect Control Guides (Bagwell et al. 1998, 1999).

Plot size in all tests was three rows (1.02 m centers) x 3.1 m, but data was recorded only from the center row. One non-planted border row was maintained between plots to reduce plant damage when workers moved between plots. Plant densities of the center row of the plots were thinned to five to six plants per m (64,582 plants/ha) within three weeks after plant emergence.

These experiments included two factors that were placed in a split-plot arrangement within a randomized complete block design with four replications. The main-plot factor consisted of application timing based on plant main-stem nodes above

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the NAWF growth stage(s). NAWF target stages included 4 levels: NAWF 6, NAWF 5, NAWF 4, and NAWF 3. NAWF measurements were initiated during the first week of flowering and were recorded weekly until plots reached the NAWF target stage. The sub-plot factor consisted of plant injury and included removal of squares (flower buds), removal of the plant main-stem terminal, and a non-damaged control. Treatments were applied on the first sampling day that NAWF had fallen below each plant maturity stage (Table 1). At each NAWF target stage, all plants were marked with a yellow snap-on-tag (A. M. Leonard, Inc., Piqua, Ohio) on the plant main-stem. Tags were placed immediately above the uppermost main-stem fruiting branch with a first position white flower. In the non-damaged control plots, the tag was used to divide the plant into upper and lower vertical zones based on each NAWF stage of plant development. In the square removal plots, all squares on fruiting branches above the tag were removed by pulling large squares by hand and using tweezers to remove pinhead squares in plant terminals. In the main-stem terminal removal treatment plots, the main-stem just above the tag was severed with scissors and completely removed.

Crop development was monitored weekly throughout the period of each experiment by recording NAWF in each plot until all plants across the test area reached NAWF ≤ 2. Plots were hand-harvested in the upper and lower zone and seedcotton weights were recorded. Data were analyzed with ANOVA and means separated according to DMRT.

Results and Discussion

Non-Damaged Plants

There were no significant test by NAWF stage interactions, for total yield ($F = 0.48$; df = 13, 61; $P = 0.9283$) and percent total yield represented in the upper zone ($F = 1.16$; df = 13, 61; $P = 0.3271$). These data were combined across all 6 tests. There were no significant differences among NAWF stages for total yield in the non-damaged plots ($F = 1.25$; df = 3, 61; $P = 0.2981$) (Table 2). There was a significant decrease in percent yield above the tag as treatments were applied from target NAWF 5-6 to NAWF 2-3. ($F = 56.91$; df = 3, 61; $P = 0.0001$). Less than 10% of the total yield was harvested above NAWF 4. However, at NAWF 4 and NAWF 5 stages 13.0 and 17.9% of the total yield was harvested (Table 2).

Square Removal

There were no significant test by NAWF stage interaction for total yield in the square stripping plots (F = 0.73; df = 3, 54; P = 0.6588) (Table 3). These data were combined across all six tests. These data are different from that in the non-damaged plots and suggest plant compensation in the lower zones (NAWF > 6) when square injury occurs in the upper zone (NAWF < 6).

Plant Main-Stem Terminal Removal

In the main-stem terminal removal plots, there was no significant test by NAWF stage interaction for total yield (F = 2.77; df = 3, 54; P = 0.0502) (Table 4). These data were combined across all 6 tests. Since the plants were unable to produce any fruit above the severed terminal, there were no yields above the tag.

These two years of data suggest that cotton in Louisiana reaches physiological "cut-out" at NAWF < 5 or NAWF < 4. Physiological "cut-out" in Louisiana is closely related to boll compensation on lower plant nodes for yield loss on the upper plant nodes (NAWF < 6). The long growing season with sufficient temperature to mature upper bolls also influence physiological cut-out. These data suggest that in order to use the University of Arkansas rules for insecticide termination program should be slightly modified for Louisiana environment.

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Table 1. Target and actual plant development stages in six Louisiana experiments during 1998 and 1999.

Location/Year (Test)	Target NAWF	Actual NAWF	Date of NAWF
MRRS 1998[a]	< 6	5.6	16 Jul
	< 5	4.9	20 Jul
	< 4	3.6	26 Jul
	< 3	2.7	31 Jul
MRRS 1999[a]	< 6	5.2	23 Jul
	< 5	4.4	26 Jul
	< 4	3.8	29 Jul
	< 3	2.3	5 Aug
MRRS 1999[b]	< 6	5.8	19 Jul
	< 5	4.6	23 Jul
	< 4	3.5	26 Jul
	< 3	2.7	29 Jul
NERS 1999[c]	< 6	5.1	20 Jul
	< 5	4.3	23 Jul
	< 4	3.3	26 Jul
	< 3	2.9	29 Jul
DLRS 1999[d]	< 6	5.7	29 Jul
	< 5	4.9	2 Aug
	< 4	3.7	5 Aug
	< 3	2.7	11 Aug
RRRS 1999[e]	< 6	5.3	30 Jul
	< 5	4.9	2 Aug
	< 4	3.7	5 Aug
	< 3	2.4	11 Aug

[a]MRRS = Macon Ridge Research Station, Winnsboro, LA (cv. NuCOTN 33[B]).
[b]MRRS = Macon Ridge Research Station, Winnsboro, LA (cv. Sure-Grow 821).
[C]NERS = Northeast Research Station, St. Joseph, LA (cv. Stoneville BXN 47).
[d]DLRS = Dean Lee Research Station, Alexandria, LA (cv. NuCOTN 33[B]).
[e]RRRS = Red River Research Station, Bossier City, LA (cv. Stoneville 474).

Table 2. Seedcotton yields influenced by NAWF stage of physiological "cut-out" in non-damaged plots in Louisiana.

NAWF Stages		Yield/(g seedcotton/ 3.1 m)			% Yield
Target	Actual	Lower Zone	Upper Zone	Total	Above Tag
5-6	5.7	904.6b	197.2a	1101.8a	17.9a
4-5	4.8	915.9b	136.9ab	1052.8a	13.0b
3-4	3.7	1043.1a	84.6c	1127.7a	7.5c
2-3	2.9	1077.5a	18.6d	1096.1a	1.7d

Means with the same letter are not significantly different (*P* = 0.05; DMRT).

Table 3. Seedcotton yields influenced by NAWF stage of physiological "cut-out" in square removal plots in Louisiana.

NAWF Stages		Yield/(g seedcotton/3.1 m)			% Yield
Target	Actual	Lower Zone	Upper Zone	Total	Above Tag
5-6	5.7	1015.9a	17.6a	1033.5a	1.7a
4-5	4.8	1001.4a	8.1b	1009.5a	0.8ab
3-4	3.7	1037.3a	6.3b	1043.6a	0.6b
2-3	2.9	1071.5a	1.1c	1072.6a	< 0.1b

Means with the same letter are not significantly different (*P* = 0.05; DMRT).

Table 4. Seedcotton yields influenced by NAWF stage of physiological "cut-out" in main-stem terminal removal plots in Louisiana.

NAWF Stages		Yield/(g seedcotton/3.1 m)			% Yield
Target	Actual	Lower Zone	Upper Zone	Total	Above Tag
5-6	5.7	1007.6ab	0	1007.6ab	0
4-5	4.8	977.5b	0	977.5b	0
3-4	3.7	1082.1a	0	1082.1a	0
2-3	2.9	1085.7a	0	1085.7a	0

Means with the same letter are not significantly different (*P* = 0.05; DMRT).