RESEARCH ANNUAL REPORT
ARKANSAS WHEAT PROMOTION BOARD

TITLE: Refinement of Armyworm Threshold in Wheat

PRIORITY AREA: Insect Control (High Priority)

INVESTIGATORS: Tim Kring (Experiment Station) and Gus Lorenz (Cooperative Extension)

OBJECTIVE : To refine the new armyworm threshold, evaluating the timing of defoliation and the response of different varieties to defoliation.

INTRODUCTION:

The armyworm is an occasional but sometimes serious pest of wheat in Arkansas during the spring. It is not uncommon to see isolated fields heavily infested while adjacent fields of the same cultivar have very few armyworm larvae. Because of the narrow profit margin for the crop, it is essential that the grower treat only the fields (or portions thereof) which will economically benefit from treatment. The 1999-2000 growing season was considered an outbreak year, with approximately 40% of fields infested by armyworm, and populations commonly exceeding double the then-published thresholds of 5-6 larvae per square foot. The following season (2000-2001) armyworm populations were expected to decline, but instead their densities nationwide were greater than any in living memory, often exceeding 25-30 larvae per square foot. Armyworm was found in every field sampled in Arkansas during the spring of 2001.

These outbreak years provided an opportunity for us to significantly accelerate our research project. Results of this project, funded by the Arkansas Wheat Promotion Board supported the contention that armyworm thresholds were set too low, causing Arkansas growers to pay for inputs which were not providing any clear return. Therefore, the threshold for treatment of spring infestations of armyworm was changed dramatically. This new threshold specifies that treatment for armyworm is unnecessary if defoliation begins after the late milk stage of development (Zadock 7.7) unless head-cutting is occurring.

Although we are confident in the application of this new threshold, we feel that it is critical to complete the threshold evaluation and refine it as necessary. Specifically, we propose to evaluate variation in response of several popular and different wheat cultivars to defoliation, and to evaluate the timing of defoliation on yield response. Although significant armyworm defoliations have not been reported prior to the late milk stage, in this project we attempt to identify the latest wheat growth stage which would be susceptible to defoliation. Secondly, the artificial defoliation tests used as an experimental basis for the new threshold have only been carried out with a single, but very popular variety (Coker 9663). Although unlikely, it is possible that yield of other varieties may be more greatly influenced by defoliation. Therefore, we expanded tests during the 2001-2002 growing season to evaluate the impact of armyworm defoliation on Sabbe, Roane, Pioneer 26R38 and Coker 9663.

METHODS:

The two objectives (susceptible stage and cultivar sensitivity) were addressed in separate tests conducted at the Arkansas Agricultural Research and Extension Center in Fayetteville. Plots were established in two fields, planted on October 14 and October 19, 2001.

Susceptible growth stage. In evaluating the latest wheat stage susceptible to defoliation, 4 plots (each 100' x 50') were established in the field. Defoliation was initiated at three different growth stages (flowering, 6.9; early milk, 7.3; and late milk, 7.7; numbers refer to Zadok scale). The last stage is the typical period when significant defoliation induced by armyworm begins. Four treatments (the three growth stages and a non-defoliated control) were applied to all wheat plants in four 1 m^2 subplots in each plot in a Latin cube design. The defoliation was done in a way to simulate armyworm damage caused during the spring. Artificial defoliations were done sequentially to mimic the progressive (bottom-up) defoliation caused by armyworm. Thus, defoliation of each plot required 4 days to complete, removing leaves in a standardized manner: (1) bottom-most fully green leaf and all lower leaves removed, (2) all leaves but top 2 leaves removed, (3) 2^{nd} leaf from top removed, (4) flag leaf removed. This sequence of defoliations initiated at the late milk stage closely followed natural defoliation observed in central Arkansas fields at the same time. These defoliations were repeated 4 times in each plot and the experiment was replicated four times. Plots were taken to yield to develop a relationship with defoliation, and seed counts and test weights were measured.

Cultivar sensitivity. The second test was conducted in a field that was planted to distinctly different wheat cultivars commonly used in Arkansas (Coker 9663, Pioneer 26R24, Roane and Saabe). Six 1 m^2 paired subplots were established in each cultivar plot, and the test was replicated 4 times. Paired plots were randomly assigned the treatment (defoliated and non-defoliated controls) upon establishment. In all cases, defoliations were initiated at an earlier growth stage (early milk, 7.3 Zadok) than is typical of armyworm damage. This was done to provide significant pressure from defoliation on each cultivar. Measured parameters (grain weight of 50 panicles, number of seeds per 50 panicles and test weight) were compared for each cultivar. The percent difference between parameters from defoliated and check plants was compared to values for Coker 9663, the standard cultivar used to establish the new threshold.

RESULTS AND DISCUSSION:

Susceptible growth stage. Data from defoliation of wheat at a growth stage concurrent with natural armyworm populations (late milk stage) reaffirmed data from our previous defoliation studies. Total defoliation of the wheat at this stage did not significantly impact grain yield, test weight or number of seed per panicle (Figs. 1-3).

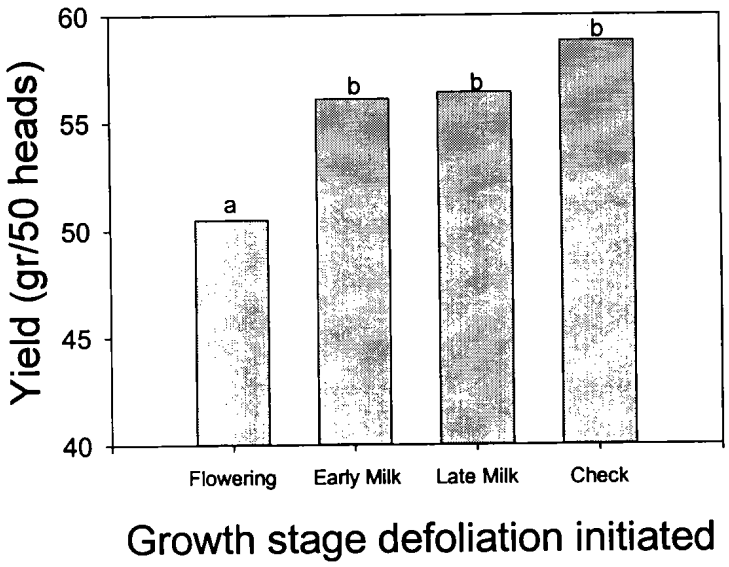

Fig. 1. Yield of wheat grain taken from a sample of 50 panicles from 1m^2 plots in which wheat was completely defoliated in a sequential manner beginning at one of three different wheat developmental stages (with non-defoliated check).

Grain yield was significantly influenced by the time at which defoliation was initiated ($P<0.05$, LSD) (Fig. 1). Yield was significantly lower in plots where defoliation was initiated at the flowering stage, prior to grain filling. Defoliation at later growth stages did not reduce yields significantly from plots which were not defoliated at all. These data support our previous findings on the ability of wheat to withstand defoliation typical of armyworm attack. Additionally, these data suggest that an early-invading population of armyworm which is beginning aggressive defoliation at or before flowering should be monitored closely.

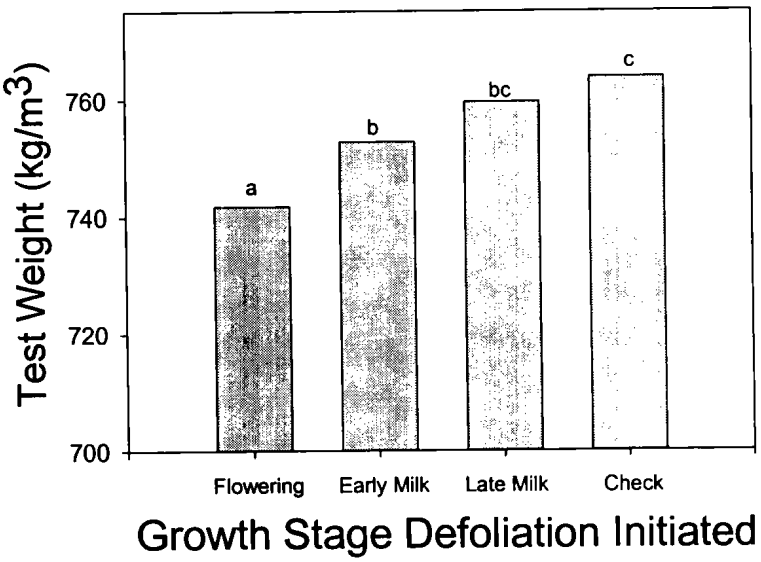

Fig. 2. Test weight of wheat grain taken from a sample of 50 panicles from 1m^2 plots in which wheat was completely defoliated in a sequential manner beginning at one of three different wheat developmental stages (with non-defoliated check).

Test weights declined significantly with earlier initiation of defoliation (Fig. 2). Defoliation typical of armyworms (initiated at late milk) did not reduce test weights from non-defoliated controls. However, defoliation initiated any earlier than this stage resulted in significant reductions in test weight. These data again support earlier work and also the concern that early armyworm infestations may cause measurable loss.

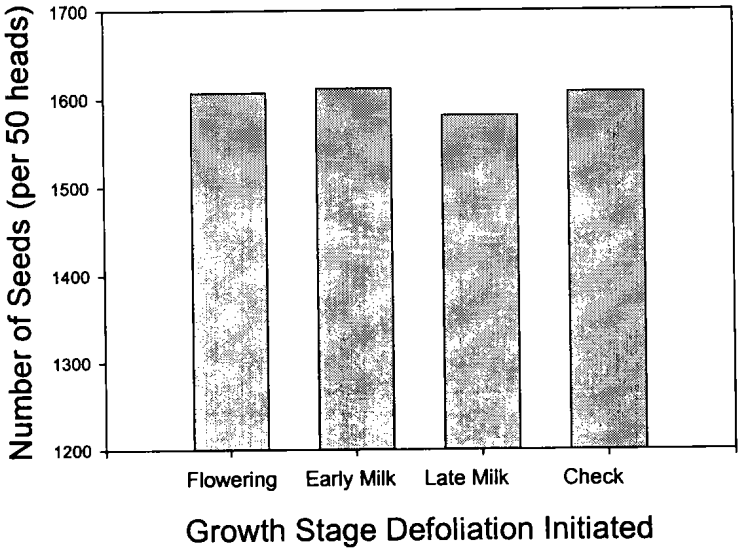

Fig. 3. Number of seeds of wheat grain taken from a sample of 50 panicles from 1m^2 plots in which wheat was completely defoliated in a sequential manner beginning at one of three different wheat developmental stages (with non-defoliated check).

Although potential seed number is determined while the panicle is still enclosed in the leaf sheath, the number of filled seeds is determined at and after flowering. The number of seeds in a panicle was not influenced by defoliation initiated at any growth stage (Fig. 3).

Cultivar susceptibility. Defoliations were conducted at a stage earlier than would be typical of armyworm infestations to induce as much stress on plants as possible. Accordingly, these early milk defoliations significantly reduced number of seed per panicle in two cultivars and yield and test weights in three cultivars (Figs. 4-6).

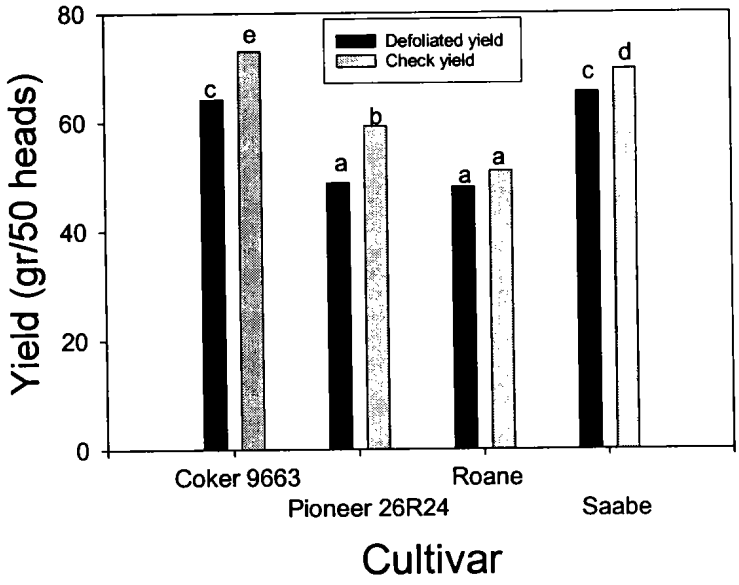

Fig. 4. Yield of wheat grain taken from a sample of 50 panicles from 1m^2 plots in which wheat of 4 different cultivars was completely defoliated in a sequential manner beginning at the early milk stage of wheat development (with non-defoliated check).

Yields were significantly reduced by defoliation in all cultivars other than Roane (Fig. 4). Yield was reduced in Coker by ~12%, Pioneer by ~17% and Saabe by ~8%. Alone, these data suggest that only Pioneer may be more affected by defoliation than was Coker, which has proven tolerant to armyworm defoliation at later growth stages typical of natural infestations.

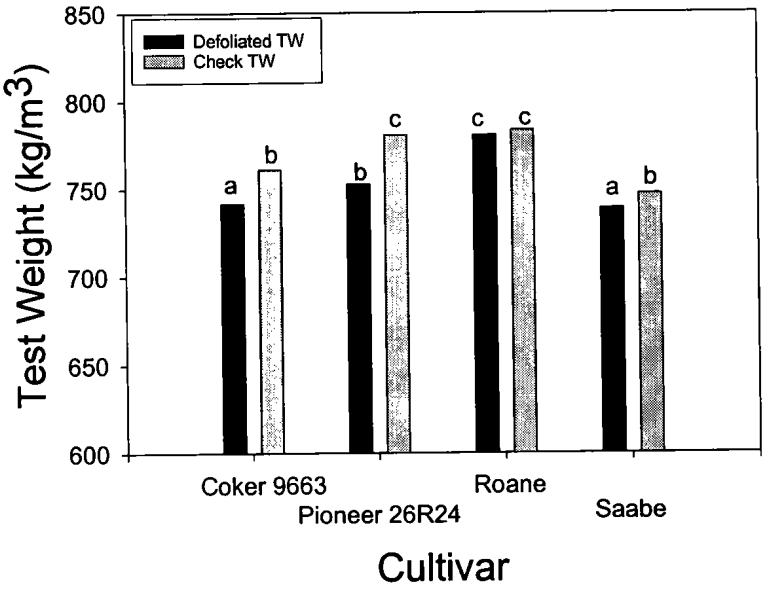

Fig. 5. Test weight of wheat grain taken from a sample of 50 panicles from 1m^2 plots in which wheat of 4 different cultivars was completely defoliated in a sequential manner beginning at the early milk stage of wheat development (with non-defoliated check).

Test weights were significantly reduced in wheat when defoliation was initiated at the early milk stage in the Coker, Pioneer and Saabe cultivars (Fig. 5). Test weights were reduced in Coker by 2.5%, Pioneer by 3.6% and Saabe by 1.1%. As with yield data, alone these data suggest that Pioneer may be more affected by defoliation than was Coker.

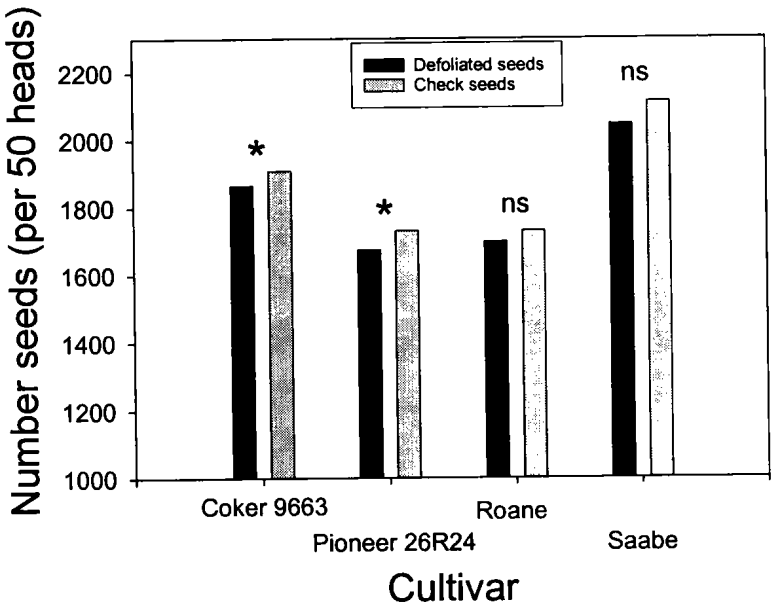

Fig. 6. Number of seeds of wheat grain taken from a sample of 50 panicles from 1m^2 plots in which wheat of 4 different cultivars was completely defoliated in a sequential manner beginning at the early milk stage of wheat development (with non-defoliated check).

The number of seeds was significantly reduced in defoliated wheat only in the Coker and Pioneer cultivars (Fig. 6). The number of seeds were reduced in Coker by 2.3% and in Pioneer by 3.2%. As with yield and test weight, the Pioneer cultivar may be more affected by defoliation than was Coker. The number of filled (and thus "countable") seed is determined early in grain filling, thus defoliation of wheat during this early stage induced a seed count affect not seen in previous years, or in the susceptible growth stage study completed this year (Fig. 3).

CONCLUSIONS:

These findings reaffirm our threshold modification made prior to the 2001-2002 production season. Defoliation initiated at a wheat growth stage typical of armyworm infestations in Arkansas (late milk stage) resulted in no impact on yield, test weight or number of seeds in Coker 9663. As anticipated, when wheat defoliation is initiated at an earlier developmental stage, the risk of yield loss increases. These data suggest that defoliation beginning during early flowering may significantly reduce yield, and populations beginning this early would warrant considerable attention. Although defoliation occurring during the early milk stage did not significantly reduced yield relative to non-defoliated controls, numerical reductions were consistent, and thus defoliation at this stage needs additional research.

The cultivars evaluated for their sensitivity to defoliation responded consistently in the different tests based on different measures of impact. Because we based our previous research on the impact of defoliation on Coker 9663, and because this cultivar repeatedly demonstrated an ability to withstand natural and artificial defoliation without yield loss, we feel the Coker cultivar represents a valuable standard of measure. The results from the current studies indicate that both Roane and Saabe appear to tolerate defoliation at least as well as the Coker cultivar. However, the Pioneer cultivar tend to respond a bit more dramatically to defoliation than Coker, so this cultivar should receive additional attention. .

Modifications to current year studies:

The exact same design of tests are planned for the 2002-2003 production season. Both study fields are planted and have excellent stands. The test to evaluate the susceptibility of the different wheat growth stages to defoliation will be conducted without modification. However, we will alter the time of defoliation of the cultivar sensitivity test. During the 2001-2002 season we conducted defoliations during the early milk stage for this test to maximize impact on the plants in order to separate response among cultivars. However, because defoliation initiated during this growth stage is atypical and would not be expected to occur in nature in a normal year, we will initiate defoliations only during the late milk stage of wheat development. Data resulting from these defoliation studies will be more directly related to defoliation induced by natural armyworm infestations.