# ASSESSMENT OF RICE STINK BUG, *OEBALUS PUGNAX*, DAMAGE TO GRAIN SORGHUM.

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## Abstract

The rice stink bug, *Oebalus pugnax*, is known to feed on the developing kernels of grain sorghum. Although previous studies have shown that the rice stink bug is capable of causing appreciable damage to sorghum, it has been over 30 years since this relationship was properly analyzed. The objectives of this study were to assess the ability of rice stink bug to damage grain sorghum at population levels around the current threshold, and to determine whether damage differs depending upon the growth stage. Damage to grain sorghum was assessed by infesting rice stink bug (RSB) on to sorghum heads using sleeve cages. Five infestation levels (0, 2, 5, 10, and 20 RSB per head) were applied across four stages of head development (emergence, flowering, soft dough, and hard dough) at 3 different regions (Northeast, Central, and South). The largest amounts of damage occurred within the emergence and flowering stages, with yield loss reaching 50% and 30% respectively, but very little damage was observed at the soft and hard dough stages. Later infestation timings showed less of a response to increasing RSB levels, but a significant response was seen even in the lowest infestation levels at emergence and flowering.

## Introduction

Grain sorghum, *Sorghum bicolor*, is a commonly grown crop in Arkansas where acres planted can exceed 400,000 acres when the price is high (NASS 2015). Sorghum in Arkansas has not historically been an intensively scouted or managed crop, especially for insects. The introduction of sugarcane aphid (SCA) in Arkansas during the 2013-2014 growing season completely changed the typical insect management regime in sorghum, especially since the pest found the environment suitable and was capable of overwintering (Seiter et al. 2015). This coupled with an increase to 450,000 acres planted in 2015 (NASS 2015) led to a large amount of producers intensively scouting a very large sorghum crop.

The University of Arkansas Cooperative Extension recommends sorghum to be scouted for SCA at least 2 times per week, and this is deemed necessary for much of the growing season, especially if aphids are known to be present within the area (Seiter et al. 2015). Many producers and consultants following these guidelines come in contact with secondary pests of sorghum, including the rice stink bug (RSB). In the time period of 2013-2015, when sorghum scouting and management for insects increased dramatically, many reports of high levels of rice stink bug were received by the extension service. Levels of rice stink bug in sorghum fields were observed above the recommended threshold for Arkansas, which is 5 rice stink bugs per head from flowering to soft dough (Studebaker et al. 2017). High levels of rice stink bug were also observed in the emergence stage, before the flowering stage was fully reached.

The rice stink bug, *Oebalus pugnax* (Hemiptera: Pentatomidae) is a major pest of rice, *Oryza sativa*, grown in the southern United States (Webb 1920). This stinkbug is a polyphagous grass feeder and feeds upon many cultivated species (wheat, sorghum, corn, and rice) and many weed species (barnyard grass, cheat, rye grass, and Johnson grass) (Douglas 1939; Odglen and Warren 1962).This pest feeds on the developing kernels of rice and other grasses beginning at the heading phase when the panicle is exerted from the boot until the end of the ripening phase, known as the hard dough phase (Swansom and Newsom 1962). Feeding by the rice stink bug in the flowering stage of rice often causes blanked kernels and direct rough rice mass loss (Swanson and Newsom 1962; Bowling 1963; Espino et al. 2007). Feeding during the later stages of heading, milk in to soft and hard dough, is associated with broken, chalky or pecky kernels. High occurrence of these pecky kernels can lead to a USDA grade reduction and often reduced mass and head rice during milling (Swanson and Newsom 1962; Bowling 1963; Espino et al. 2007).

The potential for damage in sorghum by the rice stink bug (RSB) was assessed in Texas grain sorghum by Hall and Teetes in 1982 (1982). Hall and Teetes (1982) determined that an insecticidal response was warranted when rice stink bug population levels reached 4 RSB per head at the milk stage and 8 RSB per head at soft dough. Arkansas's RSB threshold for sorghum is based solely on this work in 1982, and the difference between the two is likely due to differences in economics when Arkansas extension personal applied the threshold. No research on RSB in sorghum has been performed in Arkansas as of yet, and the work from Texas hasn't been replicated in over 30 years.

Past research indicates that Arkansas's threshold has scientific basis, but the question of whether this threshold is viable is still left unanswered for producers and consultants in Arkansas. There is also a lack of information regarding the effect of RSB on sorghum at the emergence and hard dough stages, although it is known that RSB is capable of damaging rice at these stages (Patel et al. 2006). The first objective of this study was to determine the amount of yield loss caused to grain sorghum by varying infestation levels of rice stink bug. The second objective of this study was to determine if damage caused by rice stink bug differs depending on the growth stage that the infestation occurs at.

## Materials and Methods

This experiment included 3 factors: number of rice stink bugs infested in the sleeve cage (0, 2, 5, 10, and 20 RSB per head), stage of head development when infested (emergence, flowering, soft dough, and hard dough), and the region in which this experiment was replicated (Northeast, Central, and Southeast Arkansas). For each combination of infestation level and infestation timing, 10 replications were performed, except for emergence in the southeast region which was only replicated 5 times for each infestation level. Each sleeve cage was used on one panicle and was considered independent of other panicles used in the experiment, therefore being considered a replicate. Sleeve cages used were white insect rearing sleeves, 20 X 40 cm, purchased from BioQuip (BioQuip Products, Rancho Dominguez, CA 90220, USA). No single sorghum plant received more than one sleeve cage. Cages were placed in a large plot of sorghum at each location, and replications were blocked within timing and randomized within.

Four days before the emergence stage was reached, plots were sprayed using Fastac (BASF, Ludwigshafen, Germany) and then cages were placed 2 days later for all replications at the emergence timing. Cages for all replications at the flowering, soft dough, and hard dough timings were placed when at least 50% of the flowers on the head were pollinated. Cages were marked with their infestation level and timing combination so as to avoid confusion and mistakes at the time of harvest. Sleeve cages were all placed at either the emergence or flowering timing as indicated above, and rice stink bugs were then added to each cage when the assigned stage was reached within the cage. Cages were placed at two different timings which could constitute a yield response, but since fully emerged heads were chosen, no difference was expected.

Adult and late instar rice stink bug nymphs that were caught with sweep nets from both weedy grasses and rice were used in this study. To insure viability of the individuals for the study, insects were moved in to the laboratory to be kept in small cages containing fresh plant material, a moist paper towel, and a petri dish containing cotton balls soaked in sugar water, at 75°F for at least 24 hours prior to utilization in sleeve cage trials. After the 24 hour waiting period, healthy looking adults and late instar nymphs were added to sleeve cages, and mortality was checked 24 hours afterword. Cages were then checked every 48 hours after the initial 24 hours until the next growth stage timing was reached. Any dead stinkbugs were replaced with healthy adults, and after the next growth stage was reached mortality was no longer checked, but rice stink populations were allowed to propagate unopposed until harvest.

When all sorghum cages reached maturity and were ready for harvest, stalks were cut below the cages using shears and then the head and sleeve cage together were placed in a gallon sized freezer bag. Bags were then frozen for at least two weeks to ensure mortality of stink bugs. Cages were then removed and the number of rice stink bugs were counted and sorted in to small nymphs, medium nymphs, large nymphs, and adults. Panicles were then threshed and the weight of both the empty panicle and the threshed grain was obtained. The percentage of mold coverage seen on each panicle was also recorded at the central location, for two types of mold (pink and black) that was observed. Gross seed was then adjusted for the relative size of the panicles. Adjusted gross seed weight = (gross seed weight/threshed panicle weight) x mean threshed weight of panicles. The Yield Difference was then calculated as (Mean adjusted panicle weight for the control at a particular stage) – (Adjusted panicle weight of the panicle in question). Yield loss was then determined as (Yield Difference / Mean control grain weight) x 100.

Data was compared using a three-way analysis of variance as a 5x4x3 factorial with 550 replications total. Data was also compared using a two-way ANOVA with data combined across region. Means were separated for both the 3-way and 2-way ANOVA using Fischer's protected LSD at p=0.05. Regression analysis was also utilized to better understand the relationship between stinkbug numbers and yield loss, along with their interaction with the different types of mold that was observed. Data from regression analysis was mostly inconclusive and will not be presented here.

## Results and Discussion

When yield loss was compared across regions, very few differences were seen within the emergence timing (Table 1). At 2 and 5 RSB per panicle, a lower amount of yield loss was observed in the Northeast region when compared to the central and Southeast regions. No differences in yield loss were observed between regions at both the 10 and 20 RSB levels at the emergence timing, and no differences were seen at any RSB infestation level within the flowering timing. At the soft and hard dough infestation timings, some differences were observed, but overall yield loss was low and there was no clear trend in the differences. Since very few differences were observed within the regions and a similar trend in yield loss by timing and infestation level was observed across regions, data from each region was combined and only infestation timing and infestation level were considered as factors.

Table 1. Differences in Yield Loss among Regions as Each Infestation Level within Infestation Timings

| | | Northeast | Central | Southeast |
|---|---|---|---|---|
| **Timing** | **RSB Level** | **Yield loss (%)*** | **Yield loss (%)*** | **Yield loss (%)*** |
| **Emergence** | 2 | 2.74 b | 16.39 a | 21.59 a |
| | 5 | 4.81 b | 36.87 a | 32.59 a |
| | 10 | 26.87 a | 43.20 a | 35.00 a |
| | 20 | 29.71 a | 47.73 a | 44.36 a |
| **Flowering** | 2 | 5.67 a | 11.81 a | 12.02 a |
| | 5 | 15.65 a | 11.77 a | 11.83 a |
| | 10 | 25.65 a | 28.00 a | 19.39 a |
| | 20 | 26.33 a | 43.75 a | 30.50 a |
| **Soft Dough** | 2 | -1.25 b | -8.34 b | 13.29 a |
| | 5 | 2.34 a | 2.71 a | 12.46 a |
| | 10 | 8.13 a | 14.82 a | 22.52 a |
| | 20 | 7.36 a | -4.61 b | 23.51 b |
| **Hard Dough** | 2 | -3.35 a | 3.59 ab | -0.23 a |
| | 5 | -8.41 b | 4.39 ab | 5.68 a |
| | 10 | -8.92 b | 14.62 a | -0.38 a |
| | 20 | -6.88 b | 14.52 a | -3.88 b |

*Yields followed by a different letter are significantly different using a protected LSD at $\alpha$=0.05.

Within emergence all infestation timings exhibited significantly more yield loss than the untreated check, where the current threshold of 5 RSB per panicle averaged over 50% yield loss (Table 2). A significant amount of yield loss was also observed at 2 RSB per panicle, where an average of 20% yield loss was observed. All infestation levels at flowering also showed significantly more yield loss when compared to the untreated check, although yield loss was noticeably lower than the emergence timing. 5 RSB per panicle exhibited over 20% yield loss, and 2 RSB per panicle had close to 20% yield loss. At both the soft and hard dough infestation timings, yield loss altogether was lower, and only 10 and 20 RSB per panicle in the soft dough infestation timing had significantly more yield loss than the untreated check. No significant yield loss was observed at any infestation level at the hard dough timing.

When infestation timings were compared at each infestation level, there was significantly more yield loss in emergence and flowering when compared to soft and hard dough at 2 RSB per panicle (Table 2). At 5 RSB per panicle the emergence infestation timing had significantly more yield loss than all other timings, but flowering still had over 30% yield loss and exhibited significantly more yield loss than hard and soft dough. For the infestation level of 10 RSB per panicle, all infestation timings were significantly different in sequence with emergence having the largest yield loss at >75% yield loss and hard dough showed the lowest amount of yield loss. At 20 RSB per panicle, emergence and flowering showed significantly more yield loss than both soft and hard dough, and soft dough had significantly more yield loss than hard dough with 16% yield loss.

Table 2. Comparison of Yield Loss for Infestation Levels within each Infestation Timing and for each Level at Different Timings

| Infestation Timing | Infestation Level | Yield Loss Percentage* |
|---|---|---|
| Emergence | 0 | 0.00 a, A |
| | 2 | 25.58 b, A |
| | 5 | 49.34 c, A |
| | 10 | 78.49 d, A |
| | 20 | 89.17 d, A |
| Flowering | 0 | 0.00 a, A |
| | 2 | 20.9 b, A |
| | 5 | 28.96 b, B |
| | 10 | 52.71 c, B |
| | 20 | 71.32 d, A |
| Soft Dough | 0 | 0.00 a, A |
| | 2 | 3.26 ab, B |
| | 5 | 10.39 ab, C |
| | 10 | 26.22 c, C |
| | 20 | 18.15 bc, B |
| Hard Dough | 0 | 0.00 a, A |
| | 2 | -2.46 a, B |
| | 5 | -3.49 a, C |
| | 10 | -4.36 a, D |
| | 20 | -4.65 a, C |

*Yield loss percentages followed by a different lowercased letter are significantly different within a single infestation timing, and yield loss percentages followed by a different uppercased letter are significantly different than similar infestation levels across infestation timings according to a Fischer LSD at $\alpha$=0.05.

## Summary

When comparing all three regions, similar trends in yield loss were observed for the timing by infestation level combinations. At these regions yield loss increased as infestation level increased, and across infestation timings, the only differences that were observed were in emergence. When regions were combined, significant damage was observed at all infestation levels at both the emergence and flowering infestation timings. The current threshold of 5 RSB per panicle at flowering will prevent a large amount of yield loss, and the lower infestation level of 2 RSB per panicle would also prevent a large amount of yield loss. This data shows that our threshold is one that should be followed to prevent heavy yield loss, and even more so at the earlier timing of emergence. This data also showed that lower infestation levels could possibly warrant an insecticidal response. Although significant damage was seen at the two earliest infestation timings, little damage was seen at soft and hard dough. Increasing infestation levels did not exhibit many significant yield responses at these later growth stages, even at the recommended 16 per head threshold at hard dough.

The first objective aimed to quantify the amount of damage caused by increasing infestation levels of rice stink bug, and from this data it was determined that yield loss increased significantly as the infestation level increased. The second objective looked to understand the difference in damage when infestations occurred at different growth stages, and this data determined that significantly more damage was caused to earlier growth stages such as emergence and flowering, while later growth stages showed significantly less yield loss. To further understand how infestation level effects yield loss, this experiment will be replicated, but more infestation levels between the 1-10 RSB per head level will be included and 20 RSB per head will be dropped. Also, the seed from this sample was saved to analyze the potential quality losses, considering that the rice stink bug is known to cause significant quality loss in rice. The main goal of this work is to increase confidence in Arkansas's recommendations for consultants and producers. The data from this study will lend directly towards the creation of a threshold for Arkansas, especially when combined with the economics of sorghum and the cost of the proper insecticides to create a dynamic threshold.

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