Effect of Russian Wheat Aphid on Durum Wheat Yield

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INTRODUCTION

The Russian wheat aphid (RWA), Diuraphis noxia (Mordvilko), was first recognized as a threat to Arizona small grains in 1987 (Dick & Moore 1987). In 1987 minor infestations, in which damage was confined to field margins, occurred in six counties. In 1988 infestations were generally heavier, and damage occurred throughout fields in those six counties. The situation is no longer a matter of "if infestations occur;" 86% of Pinal County fields surveyed (n=29) and 100% of Cochise County fields surveyed (n=8) were infested. Infestation levels ranged from a trace to 72% of plants surveyed. Insecticide applications to control RWA were common in 1988.

To date, economic treatment thresholds for RWA have been based on data from winter wheat production areas of South Africa and the High Plains area of the United States (Du Toit and Walters 1984; Peairs 1987). An economic treatment threshold for Arizona Durum wheat is lacking. We felt that the effect of RWA on Durum wheat was different than its effect on winter wheat; this study was undertaken to determine the effects of RWA on Durum wheat yields in grower fields.

MATERIALS AND METHODS

Two RWA-infested grower fields in Pinal County were selected. The first field, located on the farm of Royal Rush (variety WPB 881), had an initial infestation of 16-20% of tillers. The initial RWA population was 9.6 per infested tiller. The second field, located on the farm of Jack Henness (variety AG Aldente), had an initial infestation of 10-15% of tillers. The initial RWA population was 12 per infested tiller. Initial RWA populations were determined by visual count or Berlese funnel extraction of infested tillers adjacent to plots. Both infestations were within the 10-20% minimum economic treatment threshold range used in Colorado (Peairs, 1987). The Rush field was not treated for RWA control, but the Henness field was treated (0.5 lb. AI/acre disulfoton) on 24 March, just prior to heading. It was three weeks before the RWA population returned to visually-detectable levels in the Henness field.

Russian wheat aphid infestations were not evenly distributed throughout fields, so several hot spots were visually located in each field. On 5 April (Rush field) and 12 April (Henness field), three of the most heavily infested hot spots in each field were selected as the starting point for plot layout. Using each of the hot spots as the center plot, 6 more plots were located on a 45-degree angle across the 40" beds (total of 3 locations of 7 plots = 21 plots per field). Plots were constructed by lowering a 1/2-square yard template over wheat and cutting a 6-inch alley around each perimeter. Initial tiller counts were made, infested tillers (striping present) were tagged with flourescent orange twist-ties, and percent of tillers infested was determined and recorded. All plots were staked and labeled for future identification. Plots were visually examined approximately 3 weeks later to determine if RWA had moved to adjacent uninfested tillers. No increase in infestation was detected.

At maturity, heads produced by uninfested and infested tillers within each plot were harvested separately and air-dried in paper bags for 2-4 weeks. Heads were counted, threshed mechanically, and the average yield per head was calculated. For each plot, overall yield, yield per uninfested head, and yield per infested head were calculated. Protein analyses were obtained from pooled uninfested and infested grain from each field. A two-way ANOVA (Costat) was performed on infested plots over both fields, and two separate one-way ANOVAs were performed on infested plots within fields. The Student-Newman-Keuls test (Costat) was used to compare means when F was significant. Average yield over all plots within fields was used to calculate an estimate of yield per acre. The magnitude of per-head yield reduction was then used to calculate an estimate of yield- and dollar-loss per acre for the two fields in this study. Finally, a series of simple formulas were developed to enable estimation of an economic treatment threshold.

RESULTS

Russian wheat aphid infestation had a marked effect on Durum wheat yields (Table 1). A highly significant ($p = 9.3E\text{-}06$) per-head yield reduction of 44% over pooled fields was observed (Table 1). Russian wheat aphid infestation resulted in highly significant ($p = 4.61E\text{-}05$) and significant ($p = .019$) per-head yield reductions of 56% and 31% in the Rush and Henness fields, respectively. Initial infestation levels were 9.6 and 12 RWA per visually-infested tiller for the Rush and Henness fields, respectively. Loss estimates calculated for these two fields are presented in Table 2.

The formulas presented in Figure 1 can be used to calculate an economic treatment threshold. There was a significant ($p = .05$) per-head yield difference between fields. There was not a significant correlation ($r = -.03$ Rush; $r = -0.14$ Henness) between percent infestation and per-plot yield in either field; however, in the Henness field, initial stand and yield had a significant correlation ($r = .70$) There was no difference in protein level of grain harvested from uninfested or infested tillers, though there was a difference in protein level between fields (15.1% and 12.2% for Rush and Henness, respectively).

DISCUSSION

The most important result of this study is the per-head yield difference between uninfested and infested tillers. This difference provides the basis for calculating an economic treatment threshold given infestation level, yield goal, grain price, and treatment cost (Figure 1). It provides Arizona growers with a locally-developed threshold for locally-grown Durum wheat crops. When we began this study, we assumed that the effects of RWA on Durum wheats would be different than on winter wheats. However, according to F. Peairs, CSU Extension Entomologist (personal communication), the per-head yield reduction figures observed in this study are similar to yield reduction figures reported by others for winter wheat. Du Toit and Walters (1984) calculated a yield reduction of 34.6% due to RWA infestation in winter wheat. This compares favorably with our figure of 43.9%, and suggests that our yield loss figures may be applicable to winter wheat as well as Durum wheat.

Several cautions should be observed when using the results of this study to estimate economic treatment thresholds. 1. This study is based on only one season's data using just two desert valley fields. Observations suggest that both infestation levels and damage severity may be greater in Graham, Cochise, and Greenlee Counties. 2. The estimate of yield loss (% Yield Loss from Figure 1) may be conservative because it is based on pooled loss figures that include data from an insecticide-treated field and a non-treated field. 3. Actual yield reduction will probably vary with numbers of RWA per tiller. This study was conducted under what, for this year, was a low to moderate level of RWA per tiller. 4. Formulas developed in this study should only be used for wheat. The effect of RWA on barley and oats under local conditions is still unknown. Barley is generally more susceptible to RWA and oats are generally less susceptible to RWA than is wheat. 5. The results of this study are based on a relatively late infestation. An early infestation that begins prior to jointing and continues through the jointing period may result in a substantially greater yield loss.

An additional caution is that the optimum timing of insecticide applications for most economical control is not known. If a grower wishes to utilize a single application, it appears that timing the application within 2 to 3 weeks prior to flag-leaf emergence is still the best timing. However, data obtained in this study suggest that such application timing will not totally prevent loss. The Henness field still suffered a 31% per-head yield loss despite achieving nearly 100% control when insecticide application was timed to protect the flag leaf.

Several questions arose during the course of this experiment. 1. Do RWA infest all tillers (primary or secondary) equally? 2. Are infested tillers in some way under stress, apart from RWA? 3. In a varietal mixture such as that in the Henness field, do RWA exhibit any varietal preference? 4. Finally, a number of very late tillers were still green at harvest. These emerged after other tillers were nearly mature. It did not appear that any of these were RWA-infested. Why were these late tillers not infested? These four questions warrant additional study. Since the results of this study generally agree with the results of others, we do not feel that any of these four factors played a significant role in this study.

The original objective of this study was to show a correlation between percent infestation and per-plot yield. It appears that, at least in the Henness field, initial plant population had a greater effect on per-plot yield than did RWA. In the Rush field, a factor other than plant population had a greater effect on per-plot yield than did RWA. Further study using a constant plant population would be useful. In addition, we would suggest a study in which RWA population was varied. Finally, this entire study should be repeated for barley and oats.

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Table 1. Infestation status vs. yield per head.

	Yield g/head		
Status	Rush	Henness	Pooled
Uninfested	1.44 a*	1.52 a**	1.48 a*
Infested	0.63 b	1.04 b	0.83 b

SNK: *$p < .05$; **$p < .01$

Table 2. Estimated yield and dollar loss due to Russian wheat aphid.

Field	Yield lb/A	% Tillers Infested	Loss lb/A	Loss* $/A
Rush	4445	4.2	106.7	$6.66
Henness	5763	2.2	28.8	$1.79

*Based on 5-year average price of $124.88/Ton (Bloyd 1988).

Figure 1. Formulas for calculating expected yield and dollar loss based on field scouting report of percent tillers infested.

1. % Yield Reduction = 43.92(p).

   Where (p) = % tillers infested by RWA.

2. cwt/A Loss = (% Yield Reduction) X (Expected Yield cwt/A).

3. Dollar Loss = (cwt/A Loss) X (Price $/cwt).

4. If (Dollar Loss) exceeds (Treatment Cost), then treatment should be considered.