Resistance to the Wheat Curl Mite (Acari: Eriophyidae) Prevents Loss in Wheat Yield

Tom L. Harvey, T. Joe Martin, and Dallas L. Seifers

Kansas State University, Agricultural Research Center, Hays, Kansas 67601


ABSTRACT The wheat curl mite (WCM), Aceria tosichella Keifer, is a major pest of wheat because it vectors viruses that cause two important diseases—wheat streak mosaic and High Plains disease. In addition, nonviruliferous mites reduce yields by 9–30% when spikes are infested with high mite populations. Resistance to the wheat curl mite also reduces the incidence of wheat streak mosaic in both greenhouse and field tests; however, the ability of resistance to reduce yield losses from wheat curl mites feeding in spikes in the absence of the vectored viruses is unknown. We compared the effects of infestations of nonviruliferous WCM infesting spikes of the resistant hard red winter wheat line KS96WGRC40 with the susceptible cultivar 'Ike'. The resistant line reduced WCM populations by 99%, preventing losses in yield and test weight of grain. Because KS96WGRC40 was resistant to WCM strains from Kansas, Nebraska, Montana, South Dakota, Texas, and Alberta, Canada, it should be a good germplasm source for use in breeding programs.

KEY WORDS wheat curl mite, Acaria, Eriophyidae, Aceria tulipae Gramininae, wheat, Triticum aestivum, resistance

The wheat curl mite (WCM) Aceria tosichella Keifer is the only vector of the viruses that cause wheat streak mosaic (Slykhuis 1955) and high plains disease, which is a relatively new disease of both wheat and corn (Seifers et al. 1997). Wheat streak mosaic is a major disease of wheat in Kansas that has caused average annual losses of 5.5 million hectoliters (15.5 million bushels; Harvey et al. 1994). Wheat yields and test weights are also reduced by nonviruliferous WCM infesting the spikes (Harvey et al. 2000, 2002). Resistance to the WCM reduced the incidence of wheat streak mosaic in both field and greenhouse tests (Martin et al. 1984, Harvey & Martin 1988, Harvey et al. 1990, Conner et al. 1991), but the effectiveness of resistance in reducing yield losses caused by infestations of WCM in the absence of the vectored viruses is unknown. Our objective was to determine whether or not the WCM-resistant line KS96WGRC40 (Cox et al. 1999) was effective in reducing yield losses caused by nonviruliferous WCM infesting wheat spikes.

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Materials and Methods

WCM were collected from volunteer wheat in Ellis County, Kansas in October 1996 (Harvey et al. 2000) and identified as *Aceria tosichella* Keifer by J. W. Amrine (West Virginia University, Morgantown). Voucher specimens, No. 092, were deposited in the insect collection of the Department of Entomology at Kansas State University, Manhattan, Kansas. A nonviruliferous colony was established by transferring WCM eggs to ‘Tomahawk’ wheat seedlings grown in polycast tubes (2.5 cm diameter × 14-cm length; Conetainer Company, Canby, Oregon). Infested plants were covered with WCM-proof cages (Seifers et al. 1997) and the mites were allowed 3 wk to multiply at greenhouse temperatures of 18–30°C. Wheat leaves were tested at Hays, Kansas, using an enzyme-linked immunosorbent assay against wheat streak mosaic virus and high plains virus antisera to verify absence of these viruses (Seifers et al. 1996).

Hard red winter wheat test plants were the WCM susceptible cultivar ‘Ike’ (Martin et al. 1994) and the resistant line KS96WGRC40 (Cox et al. 1999). The seedlings were started in plant bands during July 2000 and vernalized for 2 mo at 8°C. In September, the seedlings were transplanted singly into 15-cm clay pots placed on greenhouse benches. The plants were arranged in a randomized complete block design with nine replications. Five infested and five uninfested plants were randomly assigned to each block. Plants were spaced at a distance of 40 cm to reduce WCM movement among plants. Each group of 10 plants was considered a replication, and there were nine replications at randomly assigned locations on the benches. Resistant and susceptible entries were held on separate benches and results analyzed independently.

Plants were infested with WCM when the awns first emerged at the base of the flag leaf of the main tillers (Feekes stage 10.2). Infested ‘Ike’ seedlings were excised from the cones, and a single seedling was attached to each plant at the base of the flag leaf where the awns were emerging. The dried seedlings were removed after 24 h, and the flag leaves were examined to verify that at least 1,000 WCM had transferred to each test plant. After infestation, the plants were maintained on the benches in their respective groups until the main tiller spikes reached physiological maturity. At this time, the individual spikes were excised from the plants and placed on sticky-tapes (Harvey & Martin 1988) to obtain an estimate of the WCM numbers per spike. After 1 wk on the tapes, the spikes were removed and then threshed to determine numbers of kernels per spike, grams per 1,000 kernels, test weight, and yield in grams per spike. Means, presented in Table 1, were subjected to analysis of variance, treatment means were separated by Student–Newman–Keuls (Steel & Torrie 1960) multiple range test at $P < 0.05$.

Results and Discussion

Numbers of WCM per spike and their effect on yield and related variables for resistant and susceptible wheat are shown in Table 1. The infested resistant line, KS96WGRC40, averaged 436 more WCM per spike than its control. There were no significant yield differences in the resistant line between infested and uninfested plants or for any of the values recorded. Most likely, WCM populations of this magnitude were insufficient to cause significant losses. Previous estimates indicated that an infestation of 450 WCM per spike in ‘Ike’ would cause a yield
reduction of 1% (Harvey et al. 2000). Although losses of 1% may be important, they are not statistically significant ($P < 0.05$). The infested susceptible cultivar, ‘Ike’, averaged 46,000 more WCM per spike than the uninfested ‘Ike’ control. This high population caused significant ($P < 0.05$) losses in test weight (12%) and grain yield (32%). Losses in both kernel weight and numbers of kernels per spike combined to account for the reduced test weight and grain yield. This agrees with previous reports on the effects of WCM infesting spikes of ‘Ike’ wheat (Harvey et al. 2000, 2002).

The WCM infestation used in this study was higher than in previous experiments; this was done to induce maximum population pressure on the resistant line. Although the WCM population generated on ‘Ike’ was more than twice that of the highest numbers so far recorded in the field, the WCM numbers infesting KS96WGRC40 remained below the economic threshold. Also, since this line was resistant to WCM strains from Kansas, Nebraska, Montana, South Dakota, Texas, and Alberta, Canada (Harvey et al. 1999) it should be a good germplasm source for use in breeding programs where resistance to WCM is needed. Because WCM infestations in wheat spikes have an adverse effect on yield, more information is needed on the occurrence and magnitude of naturally occurring WCM populations in the field.

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References Cited


