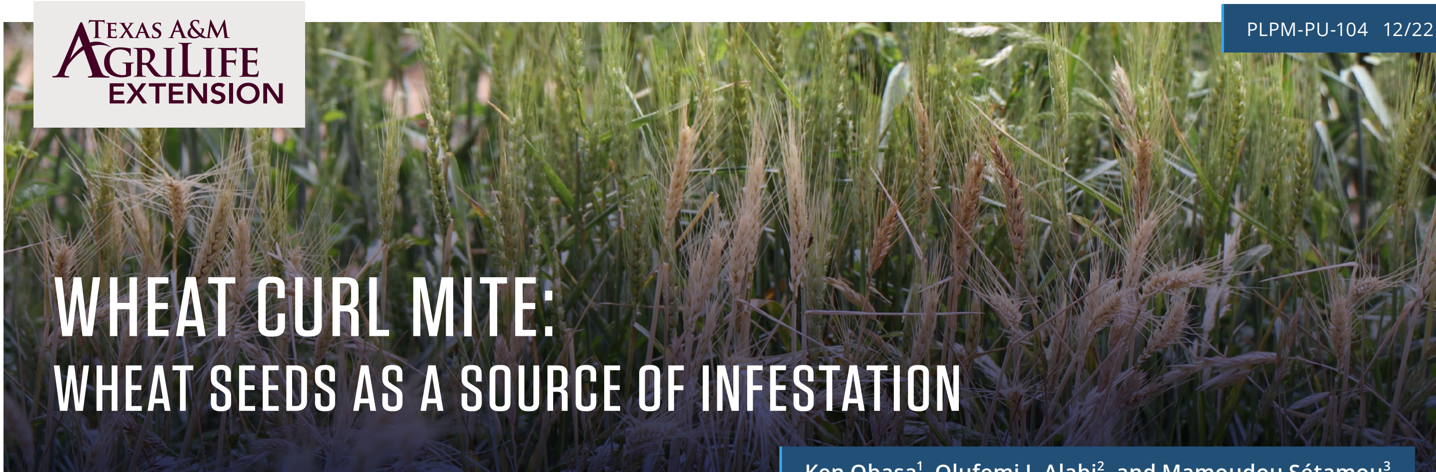
PLPM-PU-104 12/22



WHEAT CURL MITE:
WHEAT SEEDS AS A SOURCE OF INFESTATION

Ken Obasa[1], Olufemi J. Alabi[2], and Mamoudou Sétamou[3]

INTRODUCTION

The wheat curl mite (WCM) (*Aceria tosichella* Keifer) (Acari: Eriophyidae) is one of the most significant pests affecting wheat production globally. WCM are microscopic arthropods about 0.2 mm long. Besides wheat, several other grass species are also infested by WCM—including the cereal crops corn, barley, oat, rye, pearl millet, as well as cultivated (i.e., pasture) and non-cultivated grasses. Eriophyoid mites generally are an assemblage of mostly host-specific, cryptic species complex (Skoracka et al., 2013, Miller et al., 2013). The WCM, and two genotypes designated as Type 1 and Type 2 (globally, MT-1 and MT-8), are highly polyphagous and infest more than 80 plants in the family *Poaceae* (Navia et al., 2013) with worldwide distribution.

Feeding damage caused by WCM on leaf epidermal tissues—especially thin-walled bulliform cells within the whorl of a developing leaf—prevent unfurling of affected leaves and result in the characteristic leaf curling symptoms associated with WCM-infested wheat plants (Royalty and Perring, 1996). However, the greatest economic impact of WCM infestation in wheat is their ability to transmit four distinct viruses: wheat streak mosaic virus (WSMV) (genus: *Tritimovirus*; family: *Potyviridae*), Triticum mosaic virus (TriMV) (genus: *Poacevirus*; family: *Potyviridae*), High Plains wheat mosaic emaravirus (HPWMoV) (genus: *Emaravirus*; family: *Fimoviridae*), and brome streak mosaic virus (BrSMV) (genus: *Tritimovirus*; family: *Potyviridae*).

[1] Department of Plant Pathology and Microbiology, Texas A&M AgriLife Research and Extension Center, Amarillo, Texas

[2] Department of Plant Pathology and Microbiology, Texas A&M AgriLife Research and Extension Center, Weslaco, Texas

[3] Department of Agriculture, Agribusiness and Environmental Sciences, Texas A&M University-Kingsville Citrus Center, Weslaco, Texas

DISPERSAL MECHANISM OF WCM IN FIELDS

WCM are wingless, crawl slowly, and consequently are almost completely dependent on wind for passive dispersal. WCM also has a dependency of a host for food and survival. Volunteer wheat is a known major reservoir for mite population build-up. In the absence of wheat, corn is another important WCM reservoir and serves as a green bridge between successive wheat crops in the field. Reproduction and wind dispersal on actively growing wheat plants, alternative hosts such as corn, as well as cultivated and non-cultivated *Poaceae* hosts (Table 1), primarily are the known survival and dispersal mechanisms of WCM in fields.

TABLE 1. HOST RANGE OF WHEAT CURL MITE (WCM) AND WHEAT STREAK MOSAIC VIRUS (WSMV) IN DIFFERENT GRASS SPECIES.

PLANT	WCM SUSCEPTIBILITY	WSMV SUSCEPTIBILITY
Wheat	Good	Good
Corn	Poor – Fair	Susceptible
Sorghum	Poor – Good	Immune
Barley	Poor	Resistant
Oat	None	Resistant
Rye	Poor	Resistant
Johnsongrass	Poor – Good	Immune
Crabgrass	None	Susceptible

NEW WCM DISPERSAL MECHANISM IN FIELDS

In 2021, wheat samples at the soft dough-stage of development were observed with symptoms of prematurely bleached glumes (Fig. 1a) in the Texas High Plains region. The samples were collected for further investigation at the Texas High Plains Plant Disease

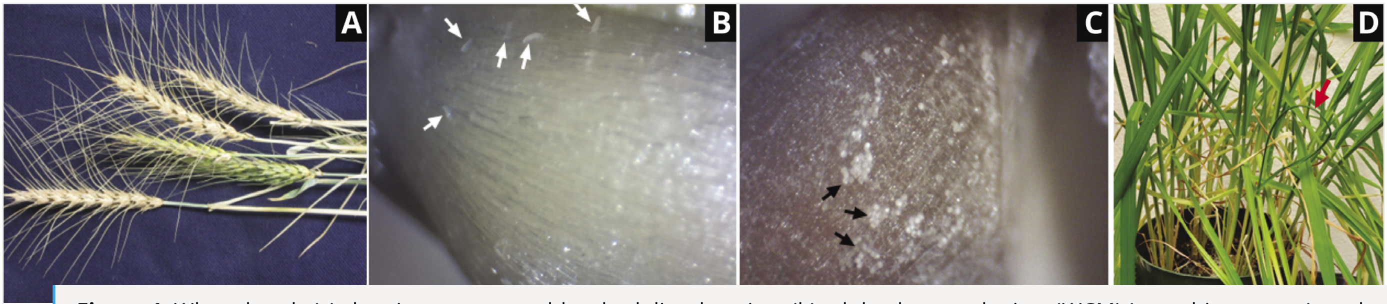


Figure 1. Wheat heads (a) showing premature bleached discoloration; (b) adult wheat curl mites (WCM) (see white arrows) on the surface of the kernel at soft-dough stage; (c) clusters of egg-like structures (see black arrows) on the surface of the kernel at the hard-dough stage; and (d) WCM-infested wheat plants showing typical WCM-induced leaf curling symptom (see red arrow).

Diagnostic Laboratory, Amarillo, Texas (*https://thppdd-lab.tamu.edu/*). Initial sample inspections showed the presence of adult WCMs (Wheat Curl Mite) on the glumes of the developing heads. Further inspection revealed the presence of several adult WCMs on the developing kernels (still at the soft dough stage) within the glumes, and especially toward the base of the developing heads (Fig. 1b).

Follow-up inspections of several field wheat samples with similar symptoms of prematurely bleached heads at the early hard dough stage of development were undertaken. Findings similarly revealed the presence of adult WCMs within the glumes of affected heads—albeit at lower densities compared with those observed in samples at the soft dough stage. Closer examinations of the developing kernels further revealed the presence of egg-like structures on the infested kernels (Fig. 1c). Eggs and adult WCM were collected and identified using morphological and molecular methods.

Morphological identification: Microscopic examination of the mites indicated that they belonged to the Eriophyid family based on their annulated and worm-like body. The presence of prodorsal tubercles and setae, which are directed to the rear, confirmed their assignment into the Aceria Keifer genus (Halawa, 2016). The adult females were whitish in color and varied from 185 to 245 mm long. They have an eight-rayed empodium on leg I—a small lobe over the gnathosoma, and a prodorsal shield with longitudinal median line restricted to the posterior half—which are consistent with features described for *Aceria tosichela* (Keifer) (Lindquist, 1996).

Molecular identification: The expected (approximately) 700 bp partial DNA fragment of the mitochondrial cytochrome c oxidase (sub-unit I; (mtCOI) gene was amplified from each of four mites' total nucleic acid sample. The generated Sanger sequences from these fragments shared 87.6 to 100 percent nucleotide (nt) identity with only isolates of *Aceria tosichella* from various parts of the world. Phylogenetic analysis also showed that the sequences derived in the study clustered closely with those of WCM isolates belonging to the previously identified MT-1 clade.

Since this WCM lifestyle of egg-laying on wheat kernels had not previously been documented, laboratory studies were conducted to investigate the viability and development of the eggs on wheat kernels. Following a 48-hour incubation of egg-infested wheat kernels, hatched eggs and larvae were observed (using a dissecting microscope) moving around in the pool of water that collected in the recessed crease areas of the seeds, whose radicles were starting to push out of the germinating seeds. In addition to demonstrating the viability of the eggs, the observation also revealed a synchronization of the timing of egg hatch with that of the host seed germination—possibly in response to exudates/chemical stimuli from the germinating seeds. A separate investigation to evaluate the likelihood of development of adult WCM on wheat plants germinated from egg-infested seeds was also undertaken in WCM-free and mite-proof cages. Adult WCM were subsequently observed on the resulting wheat plants, which also showed the typical leaf-curling symptom associated with WCM infestation (Fig. 1d). For more details and additional information on this finding, see: *https://doi.org/10.1094/PHYTOFR-04-22-0038-SC*.

This finding adds to the current understanding for the biology of WCM. However, what could not be gleaned from this study is how recent this WCM behavior has existed. Also, the duration and conditions under which seed-attached WCM eggs can remain viable is not currently known either. Furthermore, preliminary investigations suggest that mite eggs can survive on wheat seeds and remain viable for at least 2 years. Researchers overall now know that in addition to previously documented and well-known methods of dispersal in field wheat, WCM can also be introduced on seeds. Together with previous reports of seed transmission of WSMV (Dwyer et al. 2007; Jones et al. 2005; Lanoiselet et al. 2008), the implications of this finding for the epidemiology of WCM-transmitted viruses of wheat (if any) warrants investigation.

MANAGEMENT

Occasional reports of unexplained WCM infestation in wheat fields without volunteer wheat and alternate hosts within considerable distance of affected fields are common. Such cases of reported infestation could have evolved from fields inadvertently planted with seeds infested with WCM eggs. Cultural practices targeting volunteer wheat, as well as alternate hosts of WCM and use of WCM-resistant wheat varieties, currently are the most effective management strategy against WCM infestation in wheat fields. Foliar applications of insecticides and acaricides are not effective at controlling WCM. There is also a dearth of miticides labeled specifically for management of WCM in wheat that have proven to be effective.

However, unlike foliar-applied chemical treatments that target WCM, and their associated issues such as application coverage, targeting of seedborne WCM eggs presents a more direct opportunity for effective control. This in turn presents opportunities for exploring seed coating with miticides as a strategy for controlling WCM and reducing the transmission of the viruses they vector. Also, since pesticides often confer benefits against other important seeds and seedling pests, seed treatment would further ensure vigorous germination and healthy wheat seedling plants. In such a case, it is imperative to follow all pesticide label instructions for safe and effective use.

CITATIONS

Dwyer, G. I., Gibbs, M. J., Gibbs, A. J., & Jones, R. A. C. 2007. Wheat streak mosaic virus in Australia: relationship to isolates from the Pacific Northwest of the U.S. and its dispersion via seed transmission. Plant Disease, 91(2):164-170. *http://www.apsnet.org*.

Halawa, A. M., Ebrahim, A. A., Abdallah, A. A. M., Mohamad, A. A., Hosam, M. K. H., & El-Sebaay, M. M. 2016. An updated and illustrated review to the identification of the Genera Aceria Keifer and Eriophyes Von Siebold (Acari: Eriophyidae) in Egypt. Egyptian Academic Journal of Biological Sciences 9:33-56.

Jones, R. A. C., Coutts, B. A., Mackie, A. E., & Dwyer, G. I. 2005. Seed transmission of *Wheat streak mosaic virus* shown unequivocally in wheat. Plant Disease 89:1048-1050.

Lanoiselet, V. M., Hind-Lanoiselet, T. L., & Murray, G. M. 2008. Studies on the seed transmission of *Wheat streak mosaic virus*. Australasian Plant Pathology 37, 584-588. *https://doi.org/10.1071/AP08059*.

Lindquist, E. E. 1996. External anatomy and notation of structures. In: Lindquist, E. E., Sabelis, M. W., & Bruin, J. (eds). Eriophyoid Mites: Their Biology, Natural Enemies and Control. Elsevier, World Crop Pests, 6, 3-31.

Miller, A. D., Skoracka, A., Navia, D., de Mendonca, R., Szydło, W., Schultz, M., Smith, C. M., Truol, G., & Hoffmann, A. A. 2013. Phylogenetic analyses reveal extensive cryptic speciation and host specialization in an economically important mite taxon. Molecular Phylogenetics and Evolution 66, 928-940.

Navia, D., de Mendonca, R. S., Skoracka, A., Szydło, W., Knihinicki, D., Hein, G. L., et al. 2013. Wheat curl mite (*Aceria tosichella*) and transmitted viruses: an expanding pest complex affecting cereal crops. Experimental and Applied Acarology 59, 95-143. doi:10.1007/s10493-012-9633-y.

Obasa, K., Alabi, O., & Sétamou, M. 2022. Wheat curl mite: A new source of the Eriophyoid mite in wheat fields identified. PhytoFrontiers: *https://doi.org/10.1094/PHYTOFR-04-22-0038-SC*.

Royalty, R. N., & Perring, T. M. 1996. "Nature of damage and its assessment," in Eriophyoid Mites: Their Biology, Natural Enemies and Control, eds E. E. Lindquist, M. W. Sabelis, and J. Bruin (Amsterdam: Elsevier Science), 493-512. doi:10.1016/S1572-4379(96)80031-5.

Skoracka, A., Kuczyński, L., Szydło, W., & Rector, B. 2013. The wheat curl mite (*Aceria tosichella*) (Acari: Eriophyoidea) is a complex of cryptic lineages with divergent host ranges: evidence from molecular and plant bioassay data. Biological Journal of the Linnean Society 109, 165-180.