

University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Proceedings of the North American Prairie
Conferences

North American Prairie Conference

1989

Bluestem Seed Midge Influence on Sexual Reproduction of Big Bluestem: A Review

K. P. Vogel

University of Nebraska-Lincoln, kvogel1@unl.edu

G. R. Manglitz

University of Nebraska - Lincoln

Follow this and additional works at: <https://digitalcommons.unl.edu/napcproceedings>



Part of the [International and Area Studies Commons](#)

Vogel, K. P. and Manglitz, G. R., "Bluestem Seed Midge Influence on Sexual Reproduction of Big Bluestem: A Review" (1989). *Proceedings of the North American Prairie Conferences*. 2.

<https://digitalcommons.unl.edu/napcproceedings/2>

This Article is brought to you for free and open access by the North American Prairie Conference at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Proceedings of the North American Prairie Conferences by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

BLUESTEM SEED MIDGE INFLUENCE ON SEXUAL REPRODUCTION OF BIG BLUESTEM: A REVIEW

K.P. Vogel

Agricultural Research Service, U.S. Department of Agriculture,
Department of Agronomy, University of Nebraska

and

G.R. Manglitz

Agricultural Research Service, U.S. Department of Agriculture,
Department of Entomology, University of Nebraska, Lincoln, Nebraska 68583

Abstract. A Cecidomyiid midge (*Contarinia watsi* Gagne') has been identified as a significant parasite of big bluestem [*Andropogon gerardii* Vitman var. *gerardii*] by adversely affecting the production of viable seeds. The midge was first identified from specimens collected from big bluestem racemes in 1983 in eastern Nebraska. Subsequent collections and studies have shown that it is widespread in the Great Plains, and that it can reduce seed yields of big bluestem by over 40%. The midges apparently overwinter as diapausing larvae in disarticulated spikelets, emerge as adults at the time of early panicle emergence, and lay their eggs near developing caryopses. The larvae feed on the developing caryopses, pupate, and develop into adults within the florets. The adults emerge without leaving a trace. Up to three generations may occur per year with generation intervals of 13 to 16 days. The bluestem midge, in turn, is parasitized by a wasp that remains unidentified.

Key Words. big bluestem, *Andropogon gerardii*, *Contarinia watsi*, cecidomyiid, midge, seeds, prairie insects, Nebraska

INTRODUCTION

Big bluestem (*Andropogon gerardii* Vitman var. *gerardii*) is one of the dominant grasses of the tallgrass prairie. Consequently, it has been the object of numerous botanical, ecological, management, and genetic studies. However, limited information is available on the effect of insects on its life cycle. Carter *et al.* (1988) recently reported that a Cecidomyiid seed midge (*Contarinia watsi* Gagne') could reduce seed yields by over 40%. This midge, referred to as the bluestem seed midge, was first identified from specimens collected from big bluestem racemes grown in eastern Nebraska in 1983 (Carter *et al.*, 1988). The purpose of this report is to summarize the research that has been done to date on the bluestem seed midge and to describe the bluestem seed midge's effect on the sexual reproduction of big bluestem. Methods of studying the bluestem seed midge will be described.

Contarinia watsi was first reared from racemes of little bluestem [*Schizachyrium scoparium* (Michx.) Nash] collected in New Mexico by Dr. J. G. Watts and was classified and named by Dr. R. J. Gagne' (1966). Gagne' (1966) also described another species (*Contarinia halliicola* Gagne') that was reared from racemes of sand bluestem [*Andropogon gerardii* var. *paucipilus* (Nash) Fern.] collected in New Mexico by J.G. Watts. Watts and Bellottii (1967) reported that *Contarinia watsi* damaged 20% of the seed crop of little bluestem, while *Contarinia halliicola* and the larvae of another insect destroyed 30 to 60% of the sand bluestem seed crop in New Mexico.

The research that led to the discovery of the bluestem seed midge was initiated because of very low seed yields in big bluestem breeding nurseries and seed production fields that could not be attributed to weather or production practices. Insects were suspected because of previous research on the effect of the bromegrass seed midge (*Contarinia bromicola* Marilovski & Agafonova) on smooth brome (*Bromus inermis* Leyss.) seed yields in the Great

Plains and in other areas where it is grown (Neiman and Manglitz 1972). At that time, the authors were not aware of the reports by Gagne' (1966) and Watts and Bellottii (1976). Both midges belong to the class of insects commonly known as "gall midges".

The life cycle of the bromegrass midge, in contrast to that of the bluestem midge, is well known and was described by Neiman and Manglitz (1972). Diapausing larvae of the bromegrass seed midge overwinter in fallen florets on or in the top few centimeters of the soil. A cold period followed by a warmer, moist period of at least six weeks is necessary to break larval diapause. The emergence of the adults of the overwintering generation is delayed until about the time of smooth brome panicle emergence. The adult midges live only one or two days and do not feed (Agafonova 1962). The adults mate and the female then lays eggs on the interior surface of the palea of the smooth brome floret. The larvae hatch, migrate to, and feed on the developing ovary which stops the development of the flower including stamens. The larvae pupate at the feeding site when they reach maturity and within two to three days, a new generation of adults emerge to repeat the process. Three generations of bromegrass midges have been reported to occur during a single season. The last larvae of the last generation feed on fertilized ovaries and developing caryopses and, instead of pupating, develop a cocoon and enter diapause. A wasp [*Tetrastichus* sp. (Hymenoptera:Eulophidae)] can parasitize all stages of the bromegrass midge with parasitism rates as high as 90%.

A midge (*Contarinia sorghicola* Coq.) of sorghum [*Sorghum bicolor* (L.) Moench] is first in importance of all sorghum insect pests on a worldwide basis (Young and Teetes 1977). Although it occurs on an annual grain crop, its biology is similar to the bromegrass midge (Walter 1941). A single sorghum seed midge can lay 28 to 144 eggs and, in Texas, it may have up to 13 generations per year (Walter 1941). Midges also have been reported to parasitize timothy (*Phleum pratense* L.) in Finland (Raatikainen *et al.* 1967).

MATERIALS AND METHODS

Different methods can be used to collect and study midges in native or planted stands of big bluestem. The procedures that have been used and their relative merits are briefly summarized below. These methods can be used on both natural grasslands or planted fields and pastures of big bluestem.

The most precise, but also the most difficult, method used to study the bluestem seed midge is hand dissection of inflorescences. Because of the small size of big bluestem florets and seed this is a tedious procedure, and only a limited number of samples can be dissected. The adult midge can be collected with sweep nets during its brief life cycle. Since the insect spends most of its life cycle in the larval or pupal stage, its presence in big bluestem stands may not be detected by using sweep nets.

Populations of midges infesting big bluestem can be monitored during the growing season by sampling raceme-bearing culms from big bluestem plants in the study site, transporting them to a laboratory, and placing them in water-filled flasks. The flasks containing racemes are then placed in opaque insect rearing cages. Insects emerging from the racemes are collected in clear glass vials (light traps) which are inserted into the sides of the cages. Racemes can be collected weekly to monitor the midge life cycle and midge numbers. This procedure was used in the initial study on the big bluestem seed midge by Carter *et al.* (1988).

Light traps (Figure 1) can also be used to collect midges from big bluestem seed. Moistened seed is placed on top of vermiculite or perlite in sealed, opaque containers in a refrigerator at 4 C for approximately six weeks. The seed container is then removed from the refrigerator, placed on a laboratory bench, and vented with a light trap in its side. The seed needs to be kept moist. Viable seeds will germinate and produce seedlings within two to four weeks after being removed from the germinator. These seedlings can be removed when the seed is remoistened. The midges will emerge from the diapausing larvae inside the grass floret about six to eight weeks after the seed germinates. If the weight of seed and its per seed unit weight or the number of seeds that are placed in a container is known, then estimates of the degree of infestation of the seed by midges can be made. This method can also be used to determine the area of distribution of the midge. In addition to seed, litter from grasslands following seed shattering can also be used in the seed light traps. Hand dissection, sweep nets, and both the raceme and seed light traps can also be used to assay for the presence of any parasites of the midges.

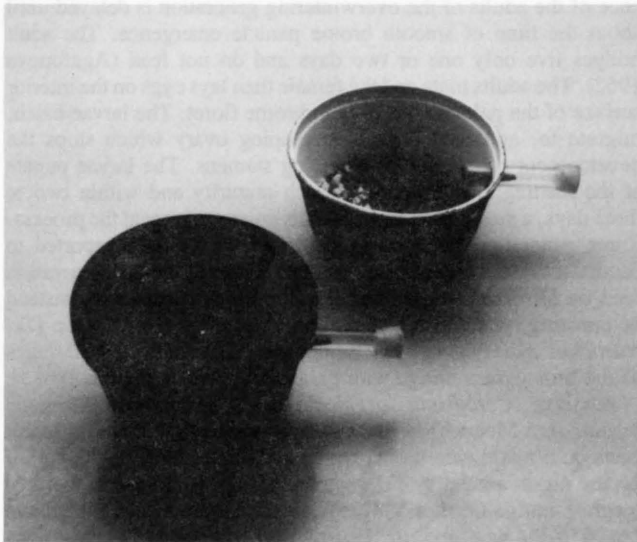


FIG. 1. A light trap for collecting midges emerging from big bluestem seed.

RESULTS AND DISCUSSION

Carter *et al.* (1988) reported that the number of bluestem seed midges that emerged from big bluestem racemes in insect rearing cages at weekly intervals indicated that at least three generations of the midge occurred in eastern Nebraska. Generations were indicated by peaks in midge numbers that occurred at about 13- to 16-day intervals (Figure 2). The first generation adults (Figure 3) are believed to emerge from diapausing larvae (Figure 4) at about the time of panicle emergence. Second and third generation midge adults left no evidence of their former presence in the floret making damage assessment difficult (Carter *et al.* 1988).

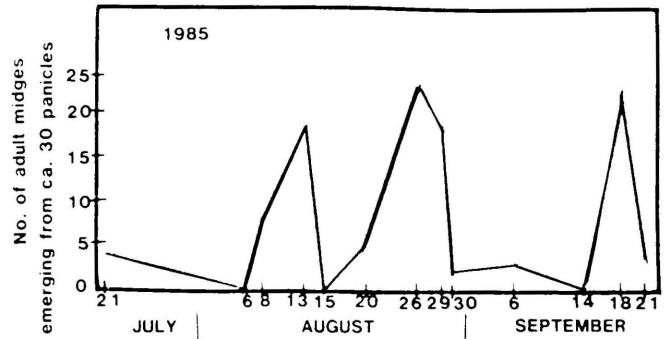


FIG. 2. The emergence of adult midges from field collected racemes of big bluestem during 1985 at Mead, Nebraska (from Carter *et al.* 1988).

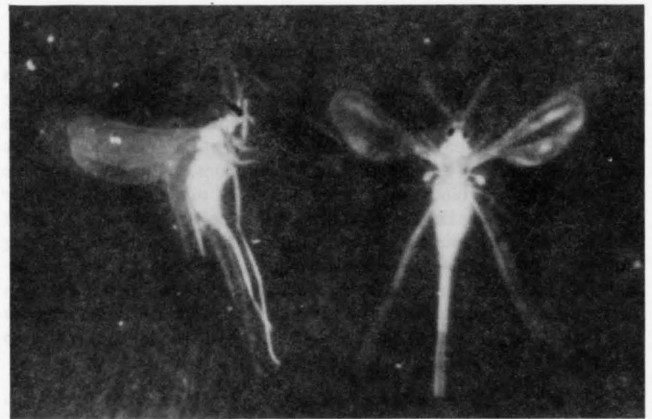


FIG. 3. The bluestem seed midge female (actual length is approximately 3 mm).



FIG. 4. Caryopses of big bluestem (left) and diapausing larvae of the bluestem midge (right).

Hand dissection of florets during the growing season demonstrated that the percentage of infested florets increased during the season, indicating an increase in the midge population during the growing season (Carter *et al.* 1988). Hand dissection of seed samples from two different seed production nurseries in eastern Nebraska indicated that the midge can substantially reduce seed yields (Table 1). The florets with small or no caryopses could have been damaged by previous generations of the midge. Carter *et al.* (1988) dissected both the pedicellate and sessile spikelets, because Boe *et al.* (1983) reported that pedicellate spikelets in big bluestem

seed production fields may be fertile. Since many of the pedicellate spikelets do not set seed, Carter *et al.* (1988) estimated that the midge reduced seed yields in a 'Pawnee' big bluestem seed field by at least 40% in 1985. Boe (1988) reported that the percentage of mature big bluestem florets that contained diapausing midge larvae was as high as 27% for sessile spikelets and 3% for pedicellate spikelets in South Dakota. Cornelius (1950) reported finding larvae of an insect in 13% of the florets of big bluestem examined in 1945. He was not able to identify the insect, but, from his description, it was probably the bluestem seed midge.

Table 1. Seed development and presence of midges in two seed fields of big bluestem cultivars in eastern Nebraska in samples collected 21 September 1985 (from Carter *et al.* 1988).

Floret categories	Field	
	'Pawnee'	'Kaw'
	-----%-----	
Normal seed	23	41
Small seed	12	34
No seed	47	18
Midge	18	7

In 1987, many farmers and ranchers attempted to harvest big bluestem seed from native grasslands in northern Nebraska because of the high seed price and what appeared to be a good seed crop based on the number of racemes. However, the amount of harvestable big bluestem seed on many of these grasslands was negligible because of empty florets. Since other factors that could have limited seed set were favorable, it is believed that the bluestem midge was responsible for the almost complete loss of this seed crop.

Midges have been reared from seed of the big bluestem cultivars 'Pawnee' and 'Kaw' and the sand bluestem cultivar 'Goldstrike' harvested in eastern Nebraska and from 'Champ' harvested in central Nebraska. Thus the bluestem seed midge appears to be widespread throughout the Central Great Plains, and it could have a substantial impact on commercial seed production in some years. Its economic impact on big bluestem seed production is substantial, since seed prices often exceed \$10/kg and can be as high as \$50/kg.

Bluestem seed midges have been collected from both burned and unburned grass seed production fields and breeding nurseries. The 'Pawnee' big bluestem field studied by Carter *et al.* (1988) (Table 1) had been burned every spring for over ten years and still had substantial numbers of midges. Controlled studies on the effect of burning on midge numbers are needed.

Wasps, which are midge parasites, were collected along with midges from grass seed fields in 1987 in Saunders and Cass counties in Nebraska. The parasites are unclassified but appear to be *Tetrastichus* sp. (Hymenoptera:Eulopidae). The number of parasites increased during the growing season as did the number of midges (Table 2). In order for the parasites to develop, midge larvae need to be present. Hence, midge and parasite numbers represent the number of caryopses damaged by that generation of the midge. Diapausing larvae of the midge and presumably of the parasitic wasp were obtained by hand dissection from seed harvested from the Cass County field.

Table 2. Big bluestem seed midges and midge parasites collected in laboratory light traps from 25 big bluestem racemes from Saunders and Cass Counties, Nebraska collected during the first week of August and September 1987.

Location	August		September	
	Midge	Parasite	Midge	Parasite
	-----Number-----			
Saunders Co.	7	1	37	43
Cass Co.	7	1	31	22

SUMMARY

The bluestem seed midge appears to be a significant parasite of big bluestem, and it has the capability to greatly reduce the production of viable seed. The discovery of the midge parasite indicates that a biological control mechanism exists. The damage to big bluestem seed production by the bluestem seed midge is likely determined by relative numbers of midges and parasites. It is assumed that the parasite's life cycle is closely matched to that of the bluestem midge which, in turn, is matched to that of big bluestem. Precipitation and other climatic factors affect seed production of big bluestem. These factors combined with the parasitism of the bluestem seed midge determine the extent of sexual reproduction of big bluestem by seed. Although it is assumed that the life cycle of the bluestem seed midge is similar to that of the bromegrass and sorghum midge, no information is available on overwintering of the bluestem seed midge in natural grasslands, mating and egg laying processes of the adults, life span and mobility of the adults, feeding behavior of the larvae, and many other aspects of the bluestem seed midge's life cycle and biology.

Midges have also been reared from indiangrass and little bluestem seed produced in Nebraska by G. R. Manglitz. Because of the great similarities between species of midges, it is not known whether the midges from the different species of grass are all the same or belong to two or more species. It is apparent that an insect complex affecting seed production exists for several important prairie grasses.

LITERATURE CITED

Agafonova, Z. Y. 1962. Development of the midge *Stenodiplosis bromicola* Mar. et Ag. (Diptera: Itonididae), in relation to peculiarities of brome biology (*Bromus inermis* Leyss. and *riparius* Rehm.) Entomological Review. 41:11-21.

Boe, A.A. 1988. Biological aspects of seed production in big bluestem. Pages 37-43. In J.R. Johnson and M.K. Beutler (eds.). Proceedings Northern Great Plains Grass Seed Symposium, Pierre, South Dakota.

Boe, A.A., J.G. Ross, and R. Wynia. 1983. Pedicellate spikelet fertility in big bluestem from eastern South Dakota. Journal of Range Management 36:131-132.

Carter, M.R., G.R. Manglitz, M.D. Rethwisch, and K.P. Vogel. 1988. A seed midge pest of big bluestem. Journal of Range Management 41:253-254.

Cornelius, D.R. 1950. Seed production of native grasses under cultivation in eastern Kansas. Ecological Monographs 20:3-29.

Gagne', R.J. 1966. The nearctic species of *Contarinia* which infest grasses (Diptera:Cecidomyiidae). Proceedings of the Entomological Society of Washington 68:318-321.

- Neiman, E.L., and G.R. Manglitz. 1972. The biology and ecology of the bromegrass seed midge in Nebraska. Nebraska Agricultural Experiment Station Research Bulletin 252.
- Raatikainen, M., O. E. Savas, and A. Tinnila. 1967. *Contarinia Kanervoi* Barnes (Dipt. Itonididae), bionomics, damage, and control. *Annales Agriculturae Fenniae* 6:145-158.
- Walter, J.G. 1941. The biology and control of the sorghum midge. United States Department of Agriculture Technical Bulletin 778.
- Watts, J.G., and A.C. Bellotti. 1967. Some new and little known insects of economic importance on range grasses. *Journal of Economic Entomology* 60:961-963.
- Young, W.R., and G. L. Teetes. 1977. Sorghum entomology. *Annual Review of Entomology* 22:193-218.