MICROFAUNAL POPULATIONS ON GLADIOLUS CORMS[1]

SIDNEY L. POE
University of Florida, Gulf Coast Experiment Station,
Bradenton, Florida 33505

ABSTRACT

The most common microfauna on field grown gladiolus in Florida included 3 species of mites, *Lasioseius subterraneous* Chant, *Rhizoglyphus robini* (Claparede), and *Histiostoma feroniarum* (Du four), an enchytraeid worm, and nematodes. These organisms appeared to be predators, saprophytes, or scavengers and fed on diseased and decayed plant tissue. Populations developed apparently in response to either disease increase or to precipitation. Disease symptoms increased with increased precipitation. Infestations appeared from sources outside the soil since attack was initiated from above ground in the neck region of the host before proceeding to the corm. Corms grown in a greenhouse in sterile soil became infested with the same species as field grown plants.

Flower crops that begin as underground rhizomes, bulbs, or corms provide an ideal microcosm below the soil for many organisms. Subterranean environments possess a high relative humidity and have minimal temperature fluctuation, while stored food material within the plant serves as an abundant and nutritious energy supply. Many soil inhabiting worms, nematodes, mites, and insects frequent this microcosm and feed upon the plants, fungi, or dead tissues. Many species of fungi and bacteria are resident flora and some attack roots and stems to bring about disease and decay. *Gladiolus grandiflorus* corms grow in such a microcosm, and populations of pests and pathogens attacking the crop are often cause for concern.

Conditions conducive to pest population development on gladiolus corms are often ill-defined or unknown. At certain times 1 or more species becomes abundant and causes corm damage. Kelsheimer (1955) reported excessive damage by nematode populations. During warm weather *Fusarium oxysporum* f. sp. *gladioli* (Massey) may become a problem, while in cooler weather *Botrytis gladiolorum* Timmermans, *Stromatinia gladioli* (Drayt), or *Stemphylium* sp. may be the major disease concern (Magie et al. 1966). *Pseudomonas marginata* (McCull) and *Curvularia* sp. are more abundant in warm wet weather (Magie et al. 1966).

Pathogen infested planting stock provides excellent medium for species of saprophytic and scavenger organisms. Several species of saprophytic mites are commonly found in association with bulbous crops and have been suspect as primary vectors of disease organisms, as primary pests of the plant itself, or as secondary saprophytes feeding on diseased tissue.

A case for saprophytic mites being primary pests of plants was given by McDaniel (1931) who stated that *Rhizoglyphus hyacinthi* (Banks) preferred solid, healthy gladiolus corms and avoided wet, decayed corms. These mites fed and "inoculated" healthy corms with bacteria inducing rot. Bald and Jefferson (1952) incriminated *R. rhizophagus* Banks as a serious primary pest of gladiolus and Jefferson et al. (1956) suggested that *R. solani* Oudemans might be a primary pest of gladiolus. Forsberg (1959,

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1965) associated *R. echinopus* (Fumouze and Robin) with bacterial scab and stated that the scab causing organism, *Pseudomonas marginata* (McCull), was transmitted by the mite. Control of mites reduced the incidence of scab but led to high incidence of Stromatinia rot, a more serious threat to commercial gladiolus production.

Young (1954) indicated that scab did not reduce the flower productiveness of gladiolus corms but did reduce market sale value of corms. Florida growers harvest and store corms and cormels, and the sale of corms is minimal. Consequently in Florida scab is not considered as great a threat as in areas where corms are grown for sale and not for flower production. Although Kelsheimer (1956) did not list the bulb mite complex as pests of gladiolus corms, recent attention has been given this problem on recropped lands where pathogens and mites are present (Engelhard 1967, Engelhard and Overman 1968).

Corms are universally contaminated with disease organisms as a result of repeated plantings of cormels to obtain flower producing size corms. It is almost certain that no stock is pathogen free (Roistacher et al. 1957, Engelhard and Overman 1968). In spite of planting stock being pathogen contaminated, Engelhard (1969) believes that *Rhizoglyphus* mites are important vectors that transmit scab organisms in Florida. Woodring (1963) is of the opinion that this group of mites are saprophytic scavengers and feed only on rotting tissue, bacteria or fungi. Transmission of pathogenic organisms would thus be secondary as would be their status as pests.

Examination of corms grown in Florida's sandy soils showed that infected or diseased corms in any state of decay were often infested with mites. However, corms without disease symptoms were not mite infested. The experiment reported herein was conducted in the fall, 1969, in an attempt 1) to establish the identity of mite populations on gladiolus corms; 2) to clarify the role of pathogens and arthropods in the soil microfaunal complex; 3) to gain insight into environmental parameters influencing population development; and 4) to determine which arthropods are primary and secondary pests of corms and whether they are of sufficient importance to warrant special concern in the development of control procedures.

Materials and Methods

One hundred 2-inch diam. (Jumbo) 'Valeria' corms were examined and found free of arthropods, before planting in plots of 10 corms each in Leon fine sand under field conditions and in sterilized flats of sand in a greenhouse. Beginning 4 weeks after planting, 1 corm was removed weekly from each plot for 10 weeks and examined under low power magnification. Specimens were mounted on glass slides and identification was made or confirmed under higher magnification (100 X). In some cases identification was provided by the Bureau of Entomology, Division of Plant Industry and Consumer Services. Presence of 10 or more individuals of different stadia of the same species constituted a population. Actual numbers were recorded when fewer than 10 individuals were present. Pathogens were identified by symptoms. Weather records, ambient tempera-

tures, and rainfall, were kept throughout the growing period on a hygrothermograph maintained by the U. S. Weather Bureau on the farm.

Results and Discussion

The organisms recovered from corms during the study, their location and role, and frequency of occurrence are listed in Table 1. Only *Rhopalosiphum rufiabdominalis* (Sasaki), an aphid, fed directly on the corm. All other organisms appeared to be scavenging on rotting tissue, feeding on the disease organisms, or preying on 1 or more of the scavenger/saprophytic species.

TABLE 1. Organisms recovered from 'Valeria' gladiolus grown in Leon sand in Florida.

Organism	Taxonomic affiliation	Site on host	Role	Frequency of occurrence
Enchytraeidae	Annelida	neck, corm	Scavenger	>50
Histiostoma feroniarum	Acarina Anoetidae	neck, corm	Saprophyte	>50
Lasioseius subterraneus	Acarina Ascaidae	neck, corm	Predator	>50
Nematodes	Cephalobus	corm	Scavenger	>50
Parasitidae	Acarina	neck, corm	Predator (?)	10
Poduridae	Collembola	neck, corm	Scavenger (?)	50
Rhizoglyphus robini	Acarina Acaridae	neck, corm	Saprophyte Scavenger	>50
Rhodacarus sp.	Rhodacaridae	corm	Predator	2
Rhopalosiphum rufiabdominalis	Aphidae	corm	Primary feeder	4
Scatopse fuscipes	Diptera	corm	Scavenger	1
Staphylinidae	Coleoptera	corm	(?)	10

Fig. 1 and 2 show maximum, average, and minimum ambient temperatures and precipitation for each week during the sampling period. One inch or more rainfall occurred during weeks 1, 4, 6, and 8 of the sampling period. Ambient temperatures fell to or below freezing on 2 occasions, but minimal temperatures were usually several degrees above freezing.

The greatest number of plants was infested with an annelid worm of the family Enchytraeidae (Table 2). These worms were small, not more than 2 cm long, pearly white to opaque, and were feeding on rotting tissue either in the neck region at the soil line or on corms. According to W. J. Harman (personal communication) members of this family of Annelida are associated with plant diseases caused by other organisms. Enchytraeids are apparently scavengers on bulb or root crops and are inhabitants of leaf litter and soil where decayed tissue is present. Their scavenging activities may aid in cleaning up necrotic plant tissue on gladiolus. This worm has not heretofore been reported on gladiolus corms in Florida.

TABLE 2. FREQUENCY OF ORGANISMS ON 'VALERIA' GLADIOLUS CORMS.

Organism	Plants affected (n=100) Field No. or %	Greenhouse No. or %	Week of highest incidence for field grown corms
Enchytraeidae	70	52	4
Stromatinia	67	70	6
Pseudomonas marginata	59	45	8
Mites (species listed below)	48	27	7,9
Lasioseius subterraneous	33	12	9
Rhizoglyphus robini	13	7	4,7
Histiostoma feroniarum	2	8	6
Nematodes (Saprophytic)	39	21	3,6
Stromatinia +			
a) Enchytraeidae	45	37	6
b) Nematodes	34	14	9
c) Mites	29	17	6
Pseudomonas +			
a) Saprophytic mites	14	12	9,10

Neck rot (*Stromatinia*) and scab symptoms occurred on more than half the plants, with the next largest numbers of plants infested by mites and nematodes (Table 2). Field grown plants showed a higher incidence of all organisms (except Stromatinia) than plants grown under greenhouse conditions. The greatest incidence of all organisms occurred during weeks with 1 inch or more rainfall or during the week following rainfall. This was particularly true of diseases which have long been associated with wet weather. Mite infestation (*Rhizoglyphus*) was more widespread 4 to 7 days following heavy rainfall. Highest infestations of worms and pathogens were found during weeks of high rainfall; however, mite infestations showed a lag and appeared higher the following week.

Three species of mites were commonly found on the plants (Table 2). *Lasioseius subterraneous* Chant (Ascaidae) appeared most common on both field grown and greenhouse grown plants. *Lasioseius* preyed upon other mites but was found on corms in the absence of any observed prey species. *Rhizoglyphus robini* (Claparede) (Acaridae) occurred most often on field grown plants but *Histiostoma feroniarum* (Dufour) (Anoetidae) occurred most often on greenhouse grown plants. Numbers of infested corms are shown in Table 2. The presence of *Lasioseius* on many plants, both infested and free of prey mites, suggests it is a soil dweller and extremely mobile in searching for prey. This species might be able to feed on fungus as an alternate host but the relationship is not firmly established. A second mesostigmatid mite, an unidentified species of Parasitidae, occurred infrequently and in low numbers on some plants. *Rhizoglyphus* mites were found feeding on decaying tissues on corms and in neck areas. *Histiostoma* appeared in association with moist lesions on corms but rarely on necrotic areas of the neck.

TABLE 3. INDIVIDUAL OCCURRENCE OF PESTS ON 'VALERIA' CORM FOR 2 SAMPLING PERIODS

	No. of plants affected (n = 20)			
	Week 5		Week 10	
Organism	Field	Greenhouse	Field	Greenhouse
Stromatinia nect rot	2	3	7	4
Pseudomonas scab	2	4	3	3
Mites	0	0	0	0
Worms	0	0	0	0
Nematodes	0	0	0	0

Table 2 also shows the incidence of visible pathogen symptoms associated with pest species and Table 3 shows the occurrence of one without the other. Worms were most abundant and appeared most often associated with neck rot; nematodes (*Cephalobus*) were next largest in numbers, and then mites collectively. Scab and mites were associated on less than 25% of corms but almost as often on greenhouse plants as on field plants.

Of the 20 corms examined at the 5 and 10 week interval (Table 3) none were found to have mites, worms, or nematodes without also showing symptoms of fungus or scab. The converse was not true since a low number of corms were diseased but did not have associated pests. This suggests that corms develop pathogenic symptoms (lesions, rot), then become attractive to the saprophytic organisms. Worms were always found feeding in decayed tissue; mites were sometimes found crawling about on corms, but populations (10 or more individuals) were always associated with necrotic tissue or scab lesions (Table 5).

TABLE 4. LOCATION OP PESTS ON THE HOST AND THE NUMBER OF CORMS AFFECTED (n = 20)

	Mites										Worms									
Location	Week Number										Week Number									
on Plant	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
Neck	1	0	3	6	7	4	3	1	0	1	6	12	8	14	13	14	8	9	3	2
Corm (Top)	0	0	0	1	1	3	8	5	8	6	0	0	9	11	8	5	5	5	3	5
Corm (Bottom)	0	0	1	1	0	2	0	3	3	4	0	0	5	5	0	3	0	4	2	2

Table 4 shows the location of the pest on the plant and the number of plants affected per week for the combined growing period. Worms were found the first week and in greater numbers in the neck region. After 3 weeks worms were recovered from the top and bottom portions of the

TABLE 5. NUMBER AND LOCATION OF POPULATION* OF PESTS ON GLADIOLUS CORMS AND WEEKS OF OCCURRENCE.

Location	Mites		Worms	
on plant	No.	Week	No.	Week
Neck	1	6	6	3,4,5,7,8,10
Corm (Top)	4	4,6,9,10	4	4,5,8,10
Corm (Bottom)	3	4,6,10	1	6

*Population = 10 or more individuals of a species.

corms. Mites occurred first on the neck regions but later became more frequent on corm tops. The least mite infestation occurred on the bottom of the corm.

Distribution data of Table 4 indicate the infestation of worms and mites began in the neck region near the surface of the ground and proceeded downward, probably in response to moisture levels and disease development. During cooler, drier weather more pests were found on the upper and lower portions of the corm. These data suggest that mites and worms are invading fields from an outside source and beginning their feeding on the upper regions of the plant or migrate from the soil to the neck region to initiate feeding on the diseased tissue.

Distributions of populations of 10 or more individuals on gladiolus plants are given in Table 5 along with the week of occurrence. In only 1 week did a population of mites occur in the neck region; populations appeared most often on the corm top or bottom. This is in contrast to the worm populations which developed most often on the neck and corm top.

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