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Project Title: Management of Sweet Corn Root and Crown Rot in the Pacific Northwest

Principal Investigator: Cynthia M. Ocamb, Ext. Specialist & Associate Professor
Botany and Plant Pathology, OSU – Corvallis
Phone: (541)737-4020, e-mail: ocambc@science.oregonstate.edu

Postdoctoral Research Assistant and Co-author: Nathan Miller, BPP, OSU

Collaborators: J. Myers (OSU Horticulture) and Rodgers Brand Vegetable Seed

Background: Leaf-firing and an associated yield reduction has been observed on sweet corn plantings in the Willamette Valley. Sweet corn fields have been affected throughout the Pacific Northwest since the syndrome was first observed in the Willamette Valley in the early 1990's. Symptoms were originally observed on the widely-planted cultivar 'Golden Jubilee' but have since been observed on other cultivars. Root rot can be prevalent in symptomatic fields but in some affected fields crown rot is the primary symptom. Fungal complexes have been recovered from affected field samples, primarily *Fusarium* species and *Pythium* species. My lab has found a preponderance of *Fusarium* species in tissues sampled from sweet corn plants with root rot and/or crown rot as well as from necrotic stalk node tissue samples. Our observations are based on sampling 10 to 30 plants per field as follows:

- Isolations made from rotted roots during 1999 (7 fields) and 2000 (6 fields).
- Isolations made from symptomatic mesocotyl during 2000 (6 fields), 2001 (8 fields), and 2004 (15 fields).
- Isolations made from necrotic (rotted) stalk node tissues during 2001 (8 fields), 2003 (10 fields), and 2004 (15 fields).
- Crown ratings in 2002-2004 season; isolations made from crown node tissues with rot symptoms during 2002 (8 fields), 2003 (10 fields), 2004 (15 fields), and 2005 (3 fields).

We continued investigations into the pathogenicity of *Fusarium* species during 2004-2006 in field, lab, and greenhouses studies. The investigations into pathogenicity in field settings were conducted in an experimental field on the OSU-Botany Farm. This work included evaluations of root rot (both primary and adventitious roots), crown rot, stalk node necrosis, and ear yield. We have evidence that there is a relationship between necrosis of the nodes and crown, ear weight, and flow of fluid through the stalk. Plants with darker nodes have lower yields and reduced fluid flow through the stalk. This trend has been found with plants collected from growers' fields during 2002, 2003, and 2004. Perhaps a fungal toxin causes necrosis at the nodes, followed by colonization of the nodes by the *Fusarium* species or perhaps the pathogens colonize nodes prior to the development of necrosis. *Fusarium* species have been isolated from symptomatic stalk tissues from plants in growers' fields during past field seasons. In greenhouse studies conducted during the spring of 2006, *F. oxysporum* var. *redolens* was found to cause significant root rot of 'Jubilee' grown in 1-gal pots of sandy-loam. Our pathogenicity experiments that suggest *Fusarium* spp. have a negative impact on plant health and yield but

other factors are probably involved as well. There is evidence to suggest that the Western Spotted Cucumber Beetle preferentially feeds on *Fusarium*-infected plants and possibly vectors *Fusarium* spp. to non-infected plants. Temperature and water levels also influence Fusarium root and crown rot.

Management of the pathogen factors that contribute to the sweet corn yield decline have been the major focus of my lab group efforts since 2000. We found root rot and crown rot to be generally decreased by soil fumigation in 2002 field experiments. Strip applications of fumigant granules (vapam) are promising for disease management. Rot of the primary root, adventitious root system, and the crown were significantly less severe in the vapam strip fumigation treatment than in the nonfumigated soil. Grower harvest showed approximately a 2 ton/acre increase in ear weight on plants grown in vapam fumigation strip, however the strip was not replicated and only sub-sampling could be done. Studies were conducted in grower fields and at the Botany and Plant Pathology Field Lab in 2002 with MC33 and Vapam in tarped fumigation plots. These studies showed similar decrease in rot of the primary root and mesocotyl when plants were grown in soil after fumigation with either material. Fumigation treatments also resulted in lower rot severity of adventitious roots. The high cost of fumigation may preclude its use as a standard response to this problem. Only a large increase in ear yield, or a reduction in other inputs, would make fumigation a reasonable option.

Disease management through the application of materials such as fungicides, biocontrol agents (biofungicides), or other materials has been investigated by my lab group. Evaluation of labeled fungicides or experimental chemistries as seed treatments have not shown significant reduction in rot severity ratings but this is not surprising as fungicide seed treatments protect plants as germlings from seed rot, damping-off, and seedling blight, but not from later season root or crown rot. In studies prior to 2006, Micro-AF (CMO-mix1) and T-22 both had significantly less rot in the adventitious root system than the conventional seed treatments, Maxim/Apron and Captan/Thiram. Companion, another biological control product, was associated with a reduced crown rot incidence while the crown rot incidence in the Maxim/Apron treatment was the highest. Mixtures of biopesticides with conventional fungicides were investigated during 2004 for control of crown rot and no treatment combination appeared to reduce crown rot incidence. The combination of the experimental Micro-AF with Maxim/Apron resulted in greater ear numbers and better tip fill, suggesting that plants from seeds receiving this treatment combination had a delay in disease onset or host reaction of the pathogens (host tolerance). Biofungicides, conventional fungicide seed treatment, seed lot of Jubilee, and kernel disinfestation prior to treatment were investigated during 2006. There were significant differences in disease measurements made among the various biofungicides evaluated during 2006; however, general trends are unclear when comparing the 20 different treatments. Correlation analyses indicate that crown grayscale and discolored ear node were significantly correlated with ear yield. Crown grayscale and stalk nodes discolored both strongly correlate with incidence of crown rot while incidence of crown rot and discolored ear nodes were both strongly correlated with stalk node discoloration. It does appear, when data are combined to represent the biofungicide and chemical treatments, that year of seed lot and disinfestation may have a slight effect on crown grayscale. Greater numbers of plots should be evaluated and may help to discern in small plot studies whether any of the biofungicides can concretely improve crown health.

Host tolerance is another management tactic that shows promise for sweet corn root and crown rot and associated yield decline. However, the development of tolerance to root and

crown rot requires a long term investment and a better understanding of the causal organisms for successful screenings. Collaborative studies on large plot (split fields on-farm) during 2002 and 2003 showed some promise for the varieties HMX7384 and Prelude but wider replication of large field screenings during 2004 showed Prelude to have lower yields. Some varieties appeared to yield well in 2004 studies and included GH2298, Punch, and HMX7384. However, adventitious root rot was relatively less severe during 2004. Primary root rot and crown rot were variable among grower sites and sweet corn varieties. Discolored crowns and crown rot were relatively high in lowest yielding variety (WSS3681). A multivariate analyses of the 29 field plots from 2004 indicate that site has a strong association on the development of root and crown rot and that these two diseases, root rot and crown rot, develop without necessarily associating with each other. They may be separate disease syndromes. On-farm studies conducted during 2005 were done in small plots rather than split field trials and rot of the adventitious roots was again generally low. On-farm trials during 2005 showed that most of the varieties screened appear to have resistance to crown rot, with the exception of Enterprise, GSS2914, and Suregold.

During 2005 and 2006, sweet corn germplasm and varieties were evaluated on the OSU Botany Farm. Columbus, Prelude, Punch, and UY0712OJ appear vigorous with lower disease level of the crown and adventitious root system in this field trial. Screenings of some inbreds showed that some inbred lines have greater tolerance to crown rot and root rot and that crown rot and stalk node rot may be a distinct syndrome from the classic stalk rot where the stalk internodes are decayed, rather than only at the stalk nodal plates as we're finding in sweet corn in the Willamette Valley. There were significant differences in disease measurements made among the hybrids and inbreds evaluated during 2006. It does appear, when evaluating the responses of the inbreds that the rot of the crown and stalk node is separate from classic stalk rot (internode rot). BIC analyses indicate that crown grayscale is an important indicator of ear weight and the true relationship may about 2 g per shade based on this data set and previous studies. Correlation analyses indicates that rot of the adventitious roots or the radicle (primary root) may not play as great of role in reducing total ear yield as does decay of the mesocotyl tissue. Crown grayscale and stalk nodes discolored both strongly correlate with incidence of crown rot. Greater numbers of plots evaluated at each sampling and greater frequency of sampling should be done with a couple of hybrids and corresponding inbreds in order to more fully understand the association of different symptoms with yield loss.

Objectives for 2007 and Accomplishments:

Objective 1: Evaluation of commercial sweet corn varieties and inbred germplasm in small plots for susceptibility to seed rot/damping-off as well as root, stalk, and crown rot.

An experimental field site study on the OSU-Botany Farm has been found to have high pressure for crown rot of sweet corn and medium pressure for root rot. This experimental corn plot was originally infested during 2000 with pathogens via incorporation of truckloads of symptomatic corn crowns, roots, and lower stalk portions from severely affected plants collected from a grower's field. This experimental field was also infested during the springs of 2002 through 2006 with a complex of *Fusarium* species by field application of colonized cornmeal-sand and/or oat kernel inoculum. Since 2001, we have used this experimental plot for sweet corn disease studies. Root and crown rot were evident in "mature" plants each year of our study and seed rot and damping-off were prominent during 2003. Sweet corn varieties evaluated during the 2007 growing season, are listed in Table 1.

Kernels were treated with Apron Maxx RTA and then sown with a belt planter. Each corn line was replicated in eight 20-foot long rows. A plot code was used so that treatments were not known while disease evaluations were made. Plants were irrigated weekly with 1.5" of water. Stand counts were taken several weeks after sowing. Plants were evaluated pre- and post-silking for rot of roots, crown, and stalk nodes as well as Western Spotted Cucumber Beetle (*Diabrotica undecimpunctata undecimpunctata*) feeding on leaves and roots. For the pre-silking evaluations (62 and 66 days after sowing), five plants at approximately the 8-leaf stage were dug from each plot (40 plants per treatment), soil was washed from the root balls of each plant, and disease severity ratings were done all in the same day. Five plants from each plot (40 plants per treatment) were sampled post-silking, approximately 87 and 88 days after sowing, for evaluation of rot of roots, crown, and stalk nodes. Three plants per plot were also examined at the 4-leaf stage (33 days after sowing) for crown and stalk node rot. Crowns of all plants sampled were digitally-captured on a flatbed scanner and analyzed for average grayscale with ImageJ.

The rot of the primary root (radicle), adventitious root system, and subcrown-internode (mesocotyl) was visually estimated on a percentage basis while rot in the crown and stalk nodes as well as rootworm feeding was rated as follows:

Nodal rating
0 = no discoloration of stalk nodes above crown
1 = node 1 above crown is discolored (dark brown)
2 = node 2 above crown is discolored (dark brown)
3 = node 3 above crown is discolored (dark brown)

Crown rot rating
0 = no discoloration of crown area (creamy-colored) or tan-light brown crown area (normal)
1 = crown rot

Root worm feeding
0 = no root worm feeding is evident
1 = root worm feeding is evident
2 = < 75 % of adventitious roots at a single whorl have root worm feeding
3 = $\geq$ 75 % of adventitious roots at a single whorl or $\geq$ 50 % of adventitious roots at two whorls have root worm feeding

Table 1. Sweet corn varieties/inbreds evaluated on the OSU-Botany Farm in 2007

Treatment #	Variety or inbreds	Treatment #	Variety or inbreds
1	Inbred A of GH1861	9	Jubilee-C
2	Inbred B of GH1861	10	Inbred A of GSS1477
3	GH-1861	11	Inbred B of GSS1477
4	Inbred A of GH8267	12	GSS1477
5	Inbred B of GH8267	13	Jubilee 2007
6	GH-8267	14	Jubilee 2006
7	Inbred A of Jubilee-C	15	Jubilee 2004
8	Inbred B of Jubilee-C	16	Jubilee 2003

Germination, rootworm damage and crown rot incidence. In the hybrid-inbred trial, hybrids tended to have higher stand numbers than parental lines and these differences were often significant (Table 2). Some differences in rootworm injury were seen, mainly on the post-silking

sample dates (~ 87 days). Hybrids tended to suffer less damage than at least one parent, and both GSS1477 inbreds showed low levels of root worm injury. The various lot years of 'Jubilee' also had only minimal rootworm damage, significantly different from 'Jubilee-C'. Both GH8267 inbreds had higher levels of rootworm injury post-silking (~ 87 days) than the hybrid, but only parent B had any injury at pre-silking. GH1861 inbred B had significantly higher level of rootworm injury on both pre- and post-silking sample dates (~ 62 and ~ 87 days, respectively) compared to all other lines.

On the pre-silking sample date, there was wide variation in incidence of crown rot (Table 2). By post-silking, a lower incidence of crown rot was found in GH1861, GH8267, GSS1477 and 'Jubilee' 2003 while 'Jubilee-C' inbreds, 'Jubilee-C', and most of the 'Jubilee' seed lot years had significantly greater incidence of crown rot. Generally, there is high inoculum pressure for Fusarium crown rot across this BPP field.

Root and Mesocotyl Rot. Little rot of roots or mesocotyl was found 33 days after planting at the 4-leaf stage (data not shown). Close to or above 90% of the primary root was rotten on average by the pre-silking sample date (~ 62 days post-planting) (Table 3). In contrast, adventitious root rot at approximately 62 days after planting was closer to 30 % or less, but were more severe, though variable by 87 days, after planting on the post-silking sample dates. Generally, adventitious root rot of the hybrids and 'Jubilee' seed lots tested was $\leq$ 60%. 'Jubilee' 2007 had significantly more severe adventitious root rot than other 'Jubilee' seed lots, and was comparable to 'Jubilee-C' inbred B. Generally, three quarters or more of the mesocotyl tissue was decayed by 62 days after planting, except for GH1861 and GH8267. By the post-silking sampling date (87 days), most lines had a high level of mesocotyl rot; only GH1861 hybrid (at 76%) was significantly less than the other lines.

Crown grayscale and stalk node discoloration. GSS1477 and its parent hybrid B stood out at the 4-leaf sample as having significantly lighter (healthier) crowns than all other sweet corn lines (Table 4). By the pre-silking sample date (~ 62 days), GSS1477 and GH1861 hybrids both had significantly lighter (healthier) crowns than their respective parental lines. By the post-silking sample date, 'Jubilee' lines and its respective seed lots (except for 'Jubilee' 2004), as well as GSS1477 and GH8267, had significantly darker crowns than many other line or inbreds lines.

There were significant differences among sweet corn lines in the number of diseased stalk nodes above the crown, but hybrids tended to behave similarly to their parental lines at the 4-leaf and pre-silk stage. At the post-silking stage (~ 87 days), GH1861 had significantly fewer stalk nodes with disease than either of its parental lines. By this late stage, there did appear to be differences in diseased stalk node numbers among the various hybrids examined; GH1861 and GH8267 ranked below GSS1477, which had significantly fewer diseased stalk nodes than the 'Jubilee' group generally.

Table 2. Stand count, root worm injury, and crown rot incidence for sweet corn varieties/inbreds screened in 2007

			Mean rootworm injury [w,x]		Incidence of crown rot [w,y]	
Trt code	**Sweet corn line**	**Stand count [z]**	**Pre-silking**	**Post-silking**	**Pre-silking**	**Post-silking**
1	GH1861 Inbred A	19 e	0.0 c	1.28 e	94 ab	87.5 abc
2	GH1861 Inbred B	19 e	1.1 a	2.53 a	32 fg	71.3 de
3	GH-1861	27 b	0.0 c	1.48 d	38 def	46.3 g
4	GH8267 Inbred A	24 bcd	0.0 c	1.95 b	98 ab	98.8 ab
5	GH8267 Inbred B	19 e	0.2 b	1.97 b	35 ef	19.2 h
6	GH-8267	26 bc	0.0 c	1.00 f	44 de	50.0 g
7	Jubilee-C Inbred A	24 cd	0.0 c	1.60 cd	99 ab	97.5 abc
8	Jubilee-C Inbred B	21 de	0.0 c	1.87 b	100 a	97.4 abc
9	Jubilee-C	26 bc	0.0 c	1.63 c	90 ab	98.7 abc
10	GSS1477 Inbred A	19 e	0.1 c	0.83 g	60 c	67.5 ef
11	GSS1477 Inbred B	11 f	0.1 c	1.03 f	90 b	84.3 cd
12	GSS1477	24 bcd	0.0 c	1.00 f	24 g	55.3 fg
13	Jubilee 2007	32 a	0.0 c	1.03 f	90 ab	100.0 a
14	Jubilee 2006	27 b	0.0 c	1.00 f	94 ab	90.8 abc
15	Jubilee 2004	33 a	0.0 c	1.18 e	89 b	84.6 bcd
16	Jubilee 2003	26 bc	0.0 c	0.95 fg	46 d	48.8 g

[w] Means are based on 5 plants per plot, replicated eight times, for a total 40 plants per treatment for the pre- and post-silking samples. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test..

[x] 0 = no root worm feeding is evident; 1 = root worm feeding is evident; 2 = < 75 % of adventitious roots at a single whorl have root worm feeding; and 3 = ≥ 75 % of adventitious roots at a single whorl or ≥ 50 % of adventitious roots at two whorls have root worm feeding.

[y] 0 = no discoloration of crown area (creamy-colored) or tan-light brown crown area (normal); 1 = crown rot.

[z] Means are based on the number of plants per plot, replicated eight times. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test.

Table 3. Rot severity of roots and mesocotyl of sweet corn varieties/inbreds screened in 2007

		Mean % primary root with rot [x]		Mean % adventitious roots with rot [x]		Mean % mesocotyl with rot [x]	
Trt #	**Variety or inbred**	**Pre-silking**	**Post-silking**	**Pre-silking**	**Post-silking**	**Pre-silking**	**Post-silking**
1	GH1861 Inbred A	95.3 abcd	100 a	21 g	44 g	89 abc	97 ab
2	GH1861 Inbred B	94.0 bcde	99 ab	24 efg	74 abc	81 cdef	100 a
3	GH-1861	97.4 abc	88 d	25 ef	48 fg	78 ef	76 d
4	GH8267 Inbred A	98.5 ab	100 a	22 fg	70 abcd	79 def	97 ab
5	GH8267 Inbred B	99.4 a	100 a	29 cd	67 bcde	94 a	98 a
6	GH-8267	97.5 abc	100 a	28 de	57 defg	57 g	99 a
7	Jubilee-C Inbred A	95.7 abcd	100 a	34 ab	59 def	92 ab	99 a
8	Jubilee-C Inbred B	100.0 a	100 a	33 ab	80 ab	87 abcde	100 a
9	Jubilee-C	93.1 cde	100 a	32 abc	55 efg	90 abc	100 a
10	GSS1477 Inbred A	89.8 e	89 d	31 abcd	63 cde	93 ab	94 b
11	GSS1477 Inbred B	97.6 abc	94 c	28 de	49 fg	83 bcdef	85 c
12	GSS1477	91.5 de	96 bc	28 de	54 efg	75 f	93 b
13	Jubilee 2007	99.8 a	100 a	34 a	81 a	89 abcd	100 a
14	Jubilee 2006	97.8 abc	99 a	31 abcd	54 efg	95 a	100 a
15	Jubilee 2004	97.7 abc	100 a	30 bcd	56 efg	97 a	100 a
16	Jubilee 2003	91.1 de	93 c	24 fg	54 efg	75 f	88 c

[x] Means are based on 5 plants per plot, replicated eight times, for a total 40 plants per treatment for the pre- and post-silking samples. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test.

Table 4. Crown grayscale and stalk node rot in sweet corn varieties/inbreds screened in 2007

		Mean grayscale pixel count of crown [x, y]			Mean stalk node # discolored [x, z]		
Trt #	**Variety or inbred**	**4-leaf stage**	**Pre-silking**	**Post-silking**	**4-leaf stage**	**Pre-silking**	**Post-silking**
1	GH1861 Inbred A	107.1 de	114.4 de	108.1 c	0.1 de	2.0 bcd	2.1 bc
2	GH1861 Inbred B	120.5 b	120.5 c	114.2 b	0.1 cde	0.4 fg	1.4 fg
3	GH1861	116.9 bc	124.2 ab	107.7 c	0.0 e	1.0 e	0.6 i
4	GH8267 Inbred A	107.9 de	116.0 d	113.8 b	0.3 abcd	2.1 bc	2.3 b
5	GH8267 Inbred B	116.9 bc	126.1 a	117.8 a	0.2 bcde	0.1 g	0.1 j
6	GH8267	116.5 bc	121.6 bc	95.5 f	0.6 a	1.0 e	0.6 i
7	Jubilee-C Inbred A	112.9 cd	105.6 i	96.7 ef	0.0 e	2.3 ab	2.9 a
8	Jubilee-C Inbred B	103.3 ef	107.1 hi	96.0 f	0.1 cde	2.6 a	2.3 b
9	Jubilee-C	108.2 de	109.9 fgh	106.2 c	0.2 bcde	2.0 bcd	2.7 a
10	GSS1477 Inbred A	117.8 bc	114.7 de	108.2 c	0.0 e	0.5 f	1.4 fg
11	GSS1477 Inbred B	130.4 a	115.8 de	114.5 ab	0.0 e	1.7 d	1.7 de
12	GSS1477	127.5 a	124.3 ab	101.2 d	0.0 e	0.5 f	1.2 gh
13	Jubilee 2007	105.4 e	112.9 ef	100.9 d	0.2 bcde	1.8 cd	1.6 ef
14	Jubilee 2006	97.7 f	110.9 fg	105.3 c	0.6 a	2.2 b	1.9 cd
15	Jubilee 2004	103.7 ef	109.4 fg	116.5 ab	0.4 abc	2.1 bc	1.3 fg
16	Jubilee 2003	119.5 b	120.6 c	99.9 de	0.4 ab	1.2 e	1.0 h

[x] Means are based on 3 plants per plot, replicated eight times, for a total 24 plants per treatment for the 4-leaf stage samples. Means are based on 5 plants per plot, replicated eight times, for a total 40 plants per treatment for the pre- and post-silking samples. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test.

[y] Grayscale was determined by ImageJ analysis of digitized crown regions and **lower grayscale values indicate darker crowns**.

[z] 0 = no discoloration of stalk nodes above crown; and 1 = node 1 above crown, or 2 = node 2 above crown or 3 = node 3 above crown is discolored.

Objective 2: Evaluation of microbial (biofungicides) and chemical treatments for suppression of sweet corn seed rot/damping-off, root rot, and crown rot.

Treatments that were included in the 2007 field evaluation are listed in Table 6. Disinfestation of 'Jubilee' seed kernels was done for removal of *Fusarium* species prior to biological seed treatments in order to optimize for growth of biocontrol microbe. The experimental design, sampling, and ratings were done in the same manner as described in Objective #1, except ear weights were collected on the last sampling date.

Table 6. Seed and soil biofungicides evaluated on the OSU-Botany Farm during 2007

Trt #	Kernel treatment	Treatment	Application rate
1	disinfested Jubilee	MicroAF (soil trt)	12.8 fl oz/A
2	disinfested Jubilee	MicroAFD (seed trt)	2 % wt
3	disinfested Jubilee	Companion (*Bacillus subtilis* GBO-3)	1 fl oz/60' row
4	disinfested Jubilee	Mycostop (streptomycete)	5 g/kg seed
5	disinfested Jubilee	Kodiak (*Bacillus subtilis* GBO-3)	0.1 oz/100 lb seed
6	non-disinfested Jubilee	Apron XL LS+Maxim XL	0.64 + 0.334 fl oz /100 lb
7	disinfested Jubilee	Apron+Maxim+MicroAFD	
8	disinfested Jubilee	Topsin 4.5FL+MicroAFD	
9	disinfested Jubilee	Topsin 4.5FL+Mycostop	
10	disinfested Jubilee	Topsin 4.5FL+Kodiak	
11	non-disinfested Jubilee	Topsin 4.5FL	
12	non-disinfested Jubilee	nontreated	
13	disinfested Jubilee	chitin	

Germination, rootworm damage and crown rot incidence. Germination was variable and most of the biological seed treatments when used alone, except for Kodiak, were associated with a reduced stand count compared to any of the chemical treatments, including a grower standard (Apron+ Maxim) (Table 7). There were significant, though slight differences in the levels of rootworm injury. Crown rot incidence was fairly high in all treatments at the pre-silk stage, by post-silking, all treatments had greater than 90% crown rot incidence.

Root and Mesocotyl Rot. Primary root rot (Table 8) was fairly severe by the pre-silking sample date (54 days after planting), and by post-silking (94 days) almost the entire primary root was rotted. However, adventitious root rot levels were still significantly reduced on day 94 by most of the biofungicide treatments relative to a grower standard (Apron+Maxim) or nontreated seeds. On the pre-silking sample date (54 days after planting), mesocotyl rot varied from 39% in Mycostop treatment to 65% in Topsin+Mycostop treatment, which was similar to the plants from nontreated seed (64%). On the post-silking sample date (day 94), mesocotyls were almost completely rotted.

Crown grayscale and stalk node discoloration. (Table 9) Nontreated seed resulted in the darkest crown grayscale values (most diseased crowns) at the 4-leaf stage (33 days after planting) and these values were significantly lower than all but three other treatments (Topsin,

Topsin+Mycostop, or Companion). On the pre-silking sample date (54 days after planting), variation in crown grayscale averages was small but overall grayscale values tended to decrease (get darker) relative to the 4-leaf stage samples. Variation was also small at the post-silk stage (94 days after planting), but again there was an overall trend for the grayscale values to get darker. Nontreated seed resulted in the darkest crowns at the post-silking stage and the differences were significant relative to four treatments (MicroAF, Mycostop, Topsin+MicroAFD, and Topsin+Kodiak). Seed treatments did not appear to reduce the number of brown nodes above the soil line in either the pre- or post-silking samples.

Ear Yields. MicroAF resulted in plants with greater ear weights compared to all other treatments (Table 10). Plants from this treatment also tended to have a greater number of ears per plant and more fully-developed ears compared to most of the rest of the other treatments.

Objective 3: Cooperate with other sweet corn projects (cultivar screenings, etc.) within and outside of OSU programs.

Sweet corn plants were rated for rot of primary roots, adventitious roots, mesocotyl, crown, and stalk nodes in three different field studies conducted by Dr. Jim Myers, OSU-Horticulture; crown nodes were also scanned for digital analyses of crown rot. In collaboration with Rodgers Seeds, the Ocamb lab group also evaluated 30 entries of a marker population for susceptibility to root rot, stalk node necrosis, and crown rot at the 4-leaf stage, 8-leaf stage, and post-silking as well as taking crown scans for digital analyses of crown rot.

Table 7. Stand count, root worm injury, and crown rot incidence in evaluations of seed and soil biofungicides with 'Jubilee' sweet corn during 2007

				Incidence of Crown Rot [w, z]	
Trt #	**Treatment**	**Stand count** [x]	**Mean rootworm injury (post-silking** [w, y]	**Pre-silking samples**	**Post-silking samples**
1	MicroAF (soil trt)	21 d	1.20 bc	75.0 bcde	96.3 abc
2	MicroAFD (seed trt)	21 d	0.98 d	80.0 ab	97.6 ab
3	Companion	25 cd	1.20 bc	67.5 de	91.3 c
4	Mycostop	25 cd	1.10 cd	68.8 cde	97.5 ab
5	Kodiak	27 abc	1.00 d	78.8 abc	92.5 bc
6	Apron+Maxim	30 ab	1.43 a	72.5 bcde	97.5 ab
7	Apron+Maxim+MicroAFD	28 abc	1.28 ab	65.4 e	93.6 abc
8	Topsin+MicroAFD	29 abc	1.43 a	80.0 ab	98.8 a
9	Topsin+Mycostop	27 abc	1.08 cd	81.3 ab	98.7 a
10	Topsin+Kodiak	25 bcd	1.05 d	87.5 a	93.6 abc
11	Topsin 4.5FL	30 ab	1.08 cd	72.5 bcde	96.3 abc
12	nontreated	32 a	1.08 cd	78.2 abcd	98.8 a
13	Chitin	24 cd	1.10 cd	67.5 de	96.3 abc

[w] Means are based on 5 plants per plot, replicated eight times, for a total 40 plants per treatment for the pre- and post-silking samples. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test..

[x] Means are based on the number of plants per plot, replicated eight times. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test.

[y] 0 = no root worm feeding is evident; 1 = root worm feeding is evident; 2 = < 75 % of adventitious roots at a single whorl have root worm feeding; and 3 = ≥ 75 % of adventitious roots at a single whorl or ≥ 50 % of adventitious roots at two whorls have root worm feeding.

[z] 0 = no discoloration of crown area (creamy-colored) or tan-light brown crown area (normal); 1 = crown rot.

Table 8. Rot severity of roots and mesocotyl in evaluations of seed and soil biofungicides with 'Jubilee' sweet corn during 2007

		Mean % primary root with rot[x]		Mean % adventitious roots with rot[x]		Mean % mesocotyl with rot[x]	
Trt #	**Treatment**	**Pre-silking**	**Post-silking**	**Pre-silking**	**Post-silking**	**Pre-silking**	**Post-silking**
1	MicroAF (soil trt)	88.7 abc	100.0 a	10.0 ef	52.3 def	42.2 de	98.6 ab
2	MicroAFD (seed trt)	88.2 abc	99.4 ab	12.9 cde	53.7 cde	46.4 cde	97.2 abc
3	Companion	83.6 c	100.0 a	14.7 bcd	57.0 bcd	51.3 bcde	97.8 abc
4	Mycostop	76.5 d	99.4 ab	14.8 bcd	51.8 ef	39.3 e	97.9 abc
5	Kodiak	94.7 a	100.0 a	15.2 bc	53.5 cde	53.7 abcd	100.0 a
6	Apron+Maxim	91.9 ab	100.0 a	21.5 a	64.5 a	54.5 abcd	99.4 ab
7	Apron+Maxim+MicroAFD	73.9 d	100.0 a	15.0 bc	44.1 g	42.6 de	97.3 abc
8	Topsin+MicroAFD	90.3 ab	99.0 ab	13.1 cd	54.8 cde	49.7 bcde	98.9 ab
9	Topsin+Mycostop	93.8 a	98.4 b	12.8 cde	48.6 fg	64.9 a	98.9 ab
10	Topsin+Kodiak	85.9 bc	100.0 a	16.3 b	51.3 ef	41.9 de	96.4 bc
11	Topsin 4.5FL	88.2 abc	99.5 ab	12.6 cdef	52.0 ef	57.9 abc	95.3 c
12	nontreated	94.4 a	100.0 a	11.8 def	61.3 ab	64.1 a	100.0 a
13	Chitin	90.2 abc	99.7 a	9.7 f	57.5 bc	62.1 ab	100.0 a

[x] Means are based on 5 plants per plot, replicated eight times, for a total 40 plants per treatment for the pre- and post-silking samples. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test.

Table 9. Crown grayscale and stalk node rot in evaluations of seed and soil biofungicides with 'Jubilee' sweet corn during 2007

		Mean grayscale pixel count of crown [x, y]			Mean stalk node # discolored [x, z]		
Trt #	**Variety or inbred**	**4-leaf stage**	**Pre-silking**	**Post-silking**	**4-leaf stage**	**Pre-silking**	**Post-silking**
1	MicroAF (soil trt)	115.7 ab	105.3 cd	95.7 ab	0.19 abc	1.8 abcd	2.40 a
2	MicroAFD (seed trt)	114.6 ab	107.9 abc	93.7 bc	0.18 abcd	1.8 abc	2.20 abcd
3	Companion	109.1 cde	109.1 ab	93.7 bc	0.43 def	1.6 abcde	2.33 ab
4	Mycostop	115.4 ab	106.4 abcd	96.1 ab	0.35 ab	1.9 a	2.33 ab
5	Kodiak	113.6 ab	109.6 ab	92.7 bc	0.46 abcde	1.9 ab	2.35 ab
6	Apron+Maxim	113.2 bc	107.5 abc	94.9 bc	0.38 bcde	1.5 cde	2.25 abc
7	Apron+Maxim+MicroAFD	113.9 ab	106.0 bcd	94.6 bc	0.25 abcd	1.3 e	2.23 abc
8	Topsin+MicroAFD	112.9 bc	109.9 a	96.2 ab	0.21 de	1.7 abcde	2.28 abc
9	Topsin+Mycostop	108.4 de	103.6 d	91.5 c	0.21 ef	1.9 ab	2.23 abc
10	Topsin+Kodiak	112.6 bcd	106.6 abcd	99.4 a	0.17 abcde	1.4 de	2.00 cd
11	Topsin 4.5FL	111.4 bcde	107.7 abc	94.3 bc	0.17 cde	1.4 e	2.10 bcd
12	nontreated	107.1 e	107.0 abcd	91.3 c	0.13 f	1.5 bcde	1.93 d
13	Chitin	118.0 a	109.4 ab	92.1 bc	0.08 a	1.6 abcde	2.20 abcd

[x] Means are based on 3 plants per plot, replicated eight times, for a total 24 plants per treatment for the 4-leaf stage samples. Means are based on 5 plants per plot, replicated eight times, for a total 40 plants per treatment for the pre- and post-silking samples. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test.

[y] Grayscale was determined by ImageJ analysis of digitized crown regions and **lower grayscale values indicate darker crowns**.

[z] 0 = no discoloration of stalk nodes above crown; and 1 = node 1 above crown, or 2 = node 2 above crown or 3 = node 3 above crown is discolored.

Table 10. Ear yields in evaluations of seed and soil biofungicides with 'Jubilee' sweet corn during 2007

Trt #	Treatment	Mean ear yield per plant (g) [x]	Mean ear # per plant [x]	Mean # of fully-developed ears/ plant [x]
1	MicroAF (soil trt)	349 a	2.38 a	1.1 a
2	MicroAFD (seed trt)	237 bc	1.93 bc	0.7 bc
3	Companion	235 bc	1.98 bc	0.7 bc
4	Mycostop	268 bc	2.12 ab	0.9 ab
5	Kodiak	256 bc	2.00 bc	0.9 ab
6	Apron+Maxim	272 b	2.05 bc	1.0 ab
7	Apron+Maxim+MicroAFD	238 bc	2.10 ab	0.7 bc
8	Topsin+MicroAFD	211 c	1.88 bc	0.5 c
9	Topsin+Mycostop	215 bc	1.90 bc	0.5 c
10	Topsin+Kodiak	234 bc	1.85 bc	0.7 bc
11	Topsin 4.5FL	217 bc	1.80 c	0.9 ab
12	nontreated	240 bc	1.83 bc	0.8 ab
13	Chitin	243 bc	1.98 bc	0.7 bc

[x] Means are based on 5 plants per plot, replicated eight times, for a total 40 plants per treatment. Numbers within a column followed by the same letter are not significantly different at $P \leq 0.05$ as determined by Fisher's protected LSD test.