

Sweet Corn Production in the Columbia Basin of Washington: Causal Agents of Seedling Blights and Prevalence of Mefenoxam Resistance

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Washington State is a major producer of sweet corn in the USA with roughly 36,400 ha planted in the semi-arid Columbia Basin annually. However, cold spring soil conditions and pathogenic species of *Fusarium*, *Pythium*, and *Rhizoctonia* can cause significant yield losses. In 2018, conventional (n = 31) and organic (n = 16) sweet corn fields were surveyed in the Columbia Basin to assess the prevalence of damping-off and seedling blights. Isolations from stunted seedlings primarily yielded *Fusarium*, *Pythium*, and *Rhizoctonia*. *Pythium ultimum* comprised 95.2% of 63 *Pythium* isolates based on sequencing the internal transcribed spacer (ITS) region of ribosomal DNA (rDNA), with only one isolate of each of *P. irregulare*, *P. rostratifingens*, and *P. sulcatum*. Of 66 *Rhizoctonia* isolates, 69.7% were *R. solani* AG-4 based on ITS rDNA sequences. Of 370 *Fusarium* isolates identified by sequencing the *translation elongation factor 1-alpha* gene, *F. equiseti*, *F. oxysporum*, *F. solani*, and *F. verticillioides* were most prevalent. Of 62 *Pythium* isolates screened for mefenoxam resistance, 38 and 35 were resistant at 10 and 100 ug/ml, respectively. The high incidence of mefenoxam resistance may account for some stand losses in fields planted with mefenoxam-treated seed. Isolates from each genus are being tested for pathogenicity to sweet corn, and the most virulent isolates used to screen sweet corn germplasm for resistance to seedling blights.

Introduction

Washington State is one of the largest sweet corn producing states with 36,400 ha planted annually, of which 31,970 ha is for processing (USDA NASS 2017). Washington is also the largest producer of organic sweet corn in the United States, with approximately 4,000 ha planted annually (USDA NASS 2017). In the semi-arid Columbia Basin (47° N 119° W), where most of the sweet corn in Washington is grown, planting extends from March through July. At early planting dates, soil temperatures <10°C can affect sweet corn germination negatively and favor development of seedling blights (Miedema 1982). Furthermore, the lack of highly effective seed treatments for certified organic production can make seedling blights a serious issue in organic production (Baird et al 1994). Public studies have not been completed on seedling blights of sweet corn in the Columbia Basin.

Objectives: As a part of the sweet corn USDA Specialty Crop Research Initiative (SCRI) CAPS project focused on improving sweet corn genetics, production, and marketability, the objectives of this project are to determine the prevalence of sweet corn seedling blights in the Columbia Basin, and to select isolates of the causal agents to screen a sweet corn association mapping panel for resistance to seedling blights.

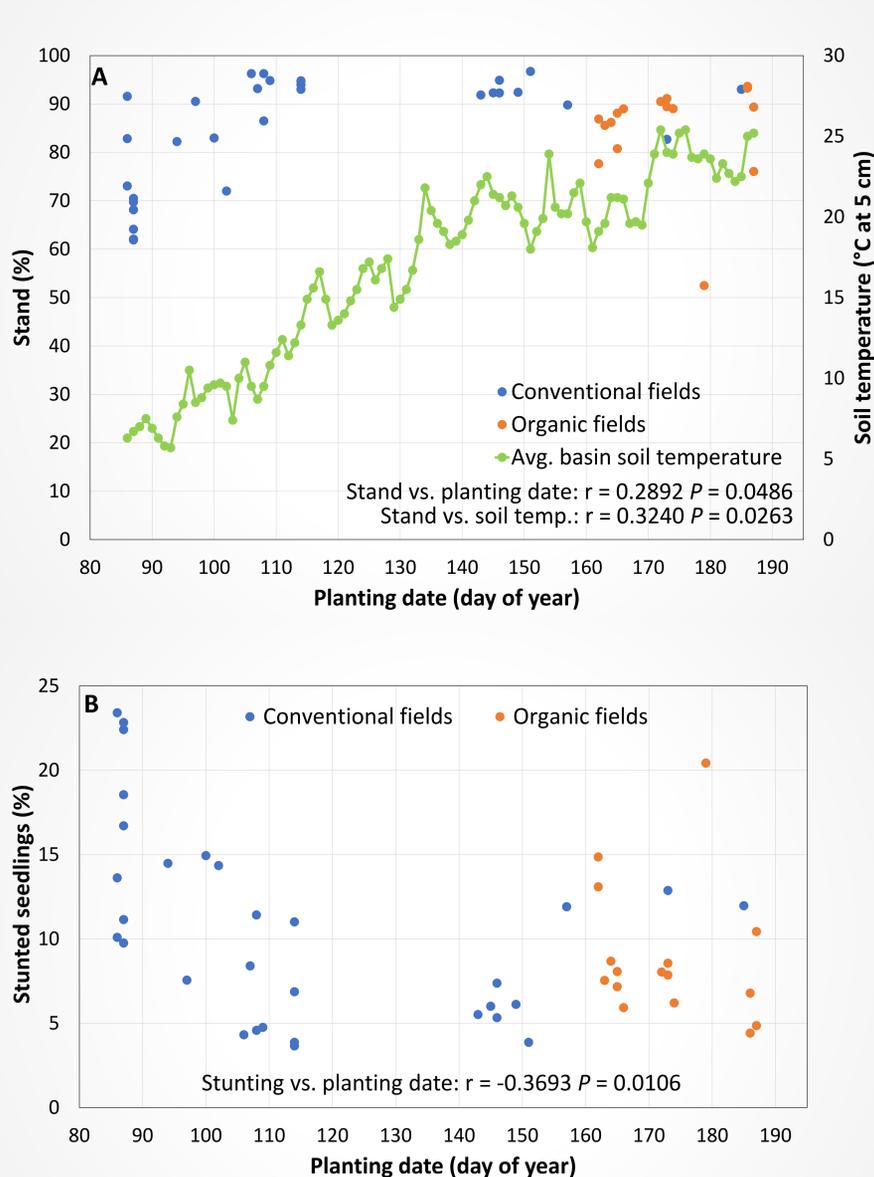


Figure 1. Percent stand (A) and incidence of stunted plants (B) in relation to planting date and average daily soil temperature for 47 sweet corn crops surveyed in the Columbia Basin of Washington State in 2018.

Methods

- Conventional (n = 31) and organic (n = 16) sweet corn fields in the Columbia Basin were surveyed in 2018 for seedling blights. Estimates of percent stand and percent stunted seedlings were calculated based on four transects in each field.
- Root and stem sections from stunted seedlings were plated onto semi-selective media. Isolates were identified based on morphology and by sequencing the ITS rDNA region for *Pythium* and *Rhizoctonia*, and the *translation elongation factor 1-alpha* gene for *Fusarium*.
- Pythium* isolates were screened for resistance to mefenoxam at 10 and 100 ug/ml.

Results

- Stands in conventional sweet corn fields ranged from 61.9 to 96.7% ($85.2 \pm 2.1\%$ mean \pm standard error). Stunting ranged from 3.7 to 23.4% ($10.6 \pm 1.0\%$). In organic fields, stands ranged from 52.5 to 93.6% ($85.0 \pm 2.5\%$) and stunting from 4.4 to 20.4% ($8.93 \pm 1.0\%$).
- Planting date was positively correlated with stand ($r = 0.2892$, $P = 0.0486$) and negatively correlated with incidence of stunting ($r = -0.3693$, $P = 0.0106$). Stands were positively correlated with soil temperature ($r = 0.3240$, $P = 0.0263$)(**Figure 1**).
- Isolations: *Fusarium* isolates (n = 350): *F. oxysporum* (32.0%), *F. verticillioides* (25.7%), *F. solani* (14.0%), *F. equiseti* (10.6%), *F. proliferatum* (4.6%), *F. fujikuroi* (4.0%), *F. lacertarum* (3.4%), *F. graminearum* (3.1%), *F. avenaceum* (0.6%), *F. commune* (0.6%), *F. acuminatum* (0.3%), and *F. concolor* (0.3%). *Pythium* isolates (n = 63): *P. ultimum* (95.2%), *P. irregulare* (1.6%), *P. rostratifingens* (1.6%), and *P. sulcatum* (1.6%). *Rhizoctonia* isolates (n = 66): *R. solani* AG-4 (69.7%), *R. solani* AG-2 (10.6%), *R. solani* AG-3 (9.1%), *Ceratobasidium* sp. AG-K (6.1%), and *Ceratobasidium* sp. AG-A (4.5%).
- Of 62 *Pythium* isolates tested, 38 (61.3%) and 35 (56.5%) were resistant to mefenoxam at 10 and 100 ug/ml, respectively (**Table 1**).
- Stand losses also occurred due to webworm, *Crambus rickseckerellus* (Kolts 1940), in 5 of 47 fields at 1-5% incidence. Wireworm; seed corn maggot; and production issues (e.g., irrigation and field preparation) were also contributors to stand losses.

Table 1. Incidence of *Pythium* isolates resistant to mefenoxam in sweet corn fields^a

Sweet corn fields	Mefenoxam concentration (ug/ml)	
	10	100
Conventional (n = 31)	23/26 (88.5%)	22/26 (84.6%)
Organic (n = 16)	15/36 (41.7%)	13/36 (36.1%)
All (n = 47)	38/62 (61.3%)	35/62 (56.5%)

^a # of resistant isolates/# tested (%)

Discussion

- Significant stand losses were documented in conventional and organic sweet corn fields (≤ 38.1 and 47.5%, respectively), i.e., seedling blights can affect stand establishment significantly in the Columbia Basin.
- Fusarium*, *Pythium*, and *Rhizoctonia* were commonly associated with stunted sweet corn plants, and diverse species of these genera were collected.
- With >50% of *Pythium* isolates resistant to mefenoxam, a replacement for mefenoxam seed treatment is needed for conventional sweet corn crops.
- Losses to seedling blights plus mefenoxam resistant *Pythium* isolates show a need for sweet corn varieties with improved seedling blight resistance.
- Crambus rickseckerellus*, a webworm (Kolts 1940), is a new pest of sweet corn in the Columbia Basin.

Future Directions

Isolates of *Pythium*, *Rhizoctonia*, and *Fusarium* will be tested for pathogenicity on sweet corn under conditions that mimic cool spring conditions. Virulent isolates will be used to screen the SCRI CAPS sweet corn association mapping panel for resistance to seedling blights.

Funding Sources:

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Select References: 1) Baird et al. 1994. Plant Dis. 78:817-821. 2) Kolts 1940. Bull. Southern CA Acad. Sci. 39:53-70. 3) Miedema 1982. Adv. Agronomy. 35:93-128. 4) USDA Nat. Agric. Stat. Survey 2017.