RESPONSE OF SUGAR BEET CULTIVARS TO THREE SPECIES OF FUSARIUM ASSOCIATED WITH SUGAR BEET YELLOWS

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Introduction

Fusarium yellows caused by *Fusarium oxysporum* f. sp. *betae* was first confirmed in MN and ND as a pathogen of sugar beet during 2004 (Windels et al., 2005). Whereas, Secor and Rivera (2005) isolated *F. oxysporum, F. sulphureum,* and *F. graminearum* from yellowed and wilted sugar beets harvested from fields located in Sabin and Georgetown, MN. There is no previous report on pathogenecity of *F. sulphureum* on sugar beet in US.

Although *Fusarium oxysporum* f. sp. betae is the primary causal agent of sugar beet yellows, *F. acuminatum*, *F. avenaceum*, *F. solani* and *F. moniliforme* have been shown to cause yellows in sugar beet grown in Western US (Hanson and Hill, 2004). In ND and MN, yellows disease has increased in recent years and was particularly severe in 2004 (Windels et al., 2004) and 2005 (Mohamed Khan *Personnel communication*). The disease is characterized by interveinal chlorosis, wilting, vascular necrosis, stunting and yellowing of the entire leaf or half leaf. Roots may be stunted without any external symptoms but transverse sections through the lower portion of the infected roots show a grayish brown discoloration of the vascular system, which may be accompanied by adventitious root proliferation along the taproot (Martyn et al., 1989).

The objective of this study was to evaluate and compare how different cultivars respond to three *Fusarium spp*. associated with yellows disease in greenhouse and field trials**.**

Materials and Method

Greenhouse Trial

Ninety eight isolates of Fusarium including *F. oxysporum, F. sulphureum,* and *F. graminearum* were recovered from sugar beet with Fusarium yellowing, wilting and vascular discoloration in 2004 and identified (Courtesy Secor and Rivera). Diseased beets were collected from American Crystal Fusarium screening plots at Sabin and Georgetown, MN. Isolates were identified based on morphological characteristics including colony color, perithecial formation and sporulation on Potato Dextrose Agar and carnation leaf agar. Pathogenicity tests were conducted using VDH 46177, a Fusarium yellows susceptible cultivar (Niehaus, 2006). Seeds of VDH 46177 were sown into cone-tainers (Stewe & Sons, Inc., Corvallis, OR) using Sunshine Mix 1 (Sun Gro Horticulture, Bellevue, WA) amended with seven ounces of Osmocote 14-14-14 (Scotts Company, Marysville, OH) per cubic yard of soil and grown for five weeks. Five week old sugar beet seedlings were removed from the containers, washed with sterilized water and the roots were dipped in a suspension of Fusarium conidia at a concentration of 40,000 macroconidia / ml for 8 minutes .Inoculated plants were transferred to fresh cone-

tainers containing Sunhsine mix 1 amended with Osmocote 14-14-14. Sterile water was used as a control. The experiment was arranged in a randomized complete block design with five replicates and 99 treatments (one plant per treatment). After transplanting, sugarbeet were transferred to an environmentally controlled growth chamber set at 70^{o}F for two days in order to reduce transplanting shock and transferred into an environmentally controlled greenhouse set at 80^{o}F. Three days after transplanting the oldest two or three leaves were removed due to yellowing not caused by Fusarium. Plants were independently examined and rated twice a week for symptoms for 60 days after inoculation using a rating scale of 0-4, developed by Hanson and Hill (2004), with 0= healthy, 1= plants stunted and wilted 2= chlorosis and necrosis of leaves, 3= crown becoming dried and brown to black in color, leaves dying and 4= death of entire plant. Re-isolation of pathogen was done for confirmation. The experiment was conducted twice.

Based on our pathogenicity test conducted in the greenhouse, the eight most virulent isolates (four *F. sulphureum*, two *F. oxysporum* and two *F. graminearum*) were selected and used to screen eight different cultivars, with four *F. sulphureum*, two *F. oxysporum* and two *F. graminearum* independently, under greenhouse conditions. Cultivars were selected based on susceptibility to Fusarium yellows (Niehaus, 2006). Previously described methods were used to conduct this experiment. The experiment was arranged in a randomized complete block design with three replicates and 72 treatments (six plants per treatment). Re-isolation of pathogen was done for confirmation. The experiment was conducted twice.

Field Trial

The field trial was conducted at Sabin, MN in 2006, in a field with a history of severe Fusarium yellows in 2005 using natural inoculum. Prior to planting, field soil was collected and tested in the laboratory to confirm presence of *Fusarium spp*. Eight commercial cultivars, the same as used in greenhouse study, were planted using a John Deere maxEmerge 2 planter into plots 11 feet wide (6 row plots with 22 inch row spacing) and 25 feet long on 18 May. Fertilization was done according to standard recommendations for sugarbeet. Plots were kept weed free using micro-rates of herbicides recommended for sugarbeet, cultivation and hand-weeding. The experimental design was a randomized complete block with four replicates. Plots were naturally infected. Plots were rated for foliar symptoms using the 0-4 scale (same as greenhouse) on 15 day intervals. The middle-two rows of plots were harvested on 11 September for yield and quality determinations. Quality analysis of Samples was done at American Crystal Sugar Company Qality Tare Laboratory, East Grand Forks, MN. Three infected roots from each of the middle two rows were sampled after harvesting to confirm the pathogen.

Summary of Results

Greenhouse Trial

Symptoms caused by the isolates varied from half leaf yellowing to full leaf yellowing, interveinal yellowing, necrosis, stunting and wilting as foliar symptoms and dark vascular necrosis on root. No infection was seen in the controls. All pathogenic isolates caused

root discoloration. *Fusarium sulphureum* was the most pathogenic followed by *F. oxysporum* and *F. graminearum*. This is the first report of *Fusarium sulphureum* being pathogenic on sugar beet in the US. This information will be useful for breeders in developing Fusarium resistant sugar beet cultivars for ND and MN.

Of the three *Fusarium species*, *F. sulphureum* and *F. oxysporum* were the most virulent to the most varieties compared to *F. graminearum* (Table 1). Varieties tested were more susceptible to *F. sulphureum* than *F. oxysporum* while *F. graminearum* caused the least disease.

Table 1. Response of eight different Sugar beet cultivars to three different Fusarium spp. in greenhouse.

Cultivars	Disease Intensity*		
	F. sulphureum	***F. oxysporum***	***F. graminearum***
VDH 46177	3.8	3.4	1.0
Seedex Magnum	1.8	1.8	0.3
Beta 4818R	1.7	1.6	0.3
Hilleshog 2463Rz	1. 6	1.6	0.3
Crystal 820	0. 9	0.8	0
VDH 66561	0.9	0.7	0
Beta 4797R	0.4	0.1	0
Crystal R434	0.1	0.1	0

*** Highest rating during 60 days**

Field Trial

F. oxysporum and *F. sulphureum* were found in soil testing. The results of the field trial can be seen in Table 2. In general, good disease presence was observed.

Table 2. Response of Eight different cultivars to naturally infected Fusarium field at Sabin, 2006

Cultivar	Disease intensity	Plant stand count	RSA	% Sucrose
VDH 46177	2.8 a	40 c	2942 c	12.0b
VDH 66561	0.8 e	53 b	7371 a	14.0a
Beta 4818R	1.2 c	52 b	5543 b	13.0ab
Beta 4797R	0.6 f	59 b	6535 ab	13.5a
Hilleshog 2463Rz	1.2 c	54 b	5833 b	13.2ab
Seedex Magnum	1.5 b	60 b	5921 b	13.9a
Crystal 820	0.9 d	57 b	6100 b	14.2a
Crystal R434	0.4 g	73 a	7321 a	13.0ab
LSD(P=0.05)	0.1	8	1037	1.4

Means within a column followed by the same letter do not significantly differ.

Conclusion

Level of resistance of cultivars from greenhouse and field are consistent with each other, although higher disease pressure was observed in greenhouse than in field. The reactions of cultivars were consistent with all three *Fusarium spp*. for resistance. Cultivar resistant to Fusarium has higher yield in comparison to less resistant cultivar.

Literature Cited

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