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DIEBACK AND WILT OF CARAGANA SEEDLINGS- MONTANA STATE NURSERY, MISSOULA

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Siberian peat-tree (*Caragana arborescens* Lam.) is an important deciduous crop at the Montana State Nursery in Missoula. Thousands of seedlings are produced each year for planting in shelterbelts throughout Montana, especially in eastern portions of the state. *Caragana* grows well in and can tolerate the cold winter and warm, dry summer conditions of eastern Montana. Therefore, this species is in high demand for plantings in farming and ranching communities where natural tree cover is sparse.

Caragana has been produced at the Montana State Nursery for many years, usually without problems. However, during the summer of 1990, growers noticed abnormal levels of dieback and wilting of some seedlings (figure 1). Foliage at the tips of branches became discolored and progressively died back, indicative of wilting. Although weather was hot when symptoms became noticeable, growers could not understand why seedlings were being damaged. Standard cropping practices that had produced vigorous, healthy seedlings in the past were followed. Such practices included restricting the amount of irrigation to limit growth; very large seedlings are undesirable from the standpoint of lifting, storage, and shipment to the field. Limiting irrigation usually does not result in much damage to seedlings because of their extreme drought resistance. Growers were concerned that perhaps root-infecting fungi might be important in eliciting wilting symptoms. Therefore, investigations were conducted to determine extent of root colonization by fungi that might be capable of causing wilting symptoms.

Thirteen seedlings with various amounts of wilting were carefully lifted from seedbeds to remove as many roots as possible. They were refrigerated until analyzed in the laboratory. Seedling roots were washed extensively to remove particles of soil and examined under the dissecting microscope for evidence of necrosis. Hand sections were cut through vascular tissues for examination of staining that might accompany infection with wilt organisms (Beckman 1987). Pieces of root about 2-3 mm in length were aseptically excised from root systems, surface sterilized in a 10% bleach solution (0.525% aqueous sodium hypochlorite), and rinsed with sterile water. Root pieces were incubated on four different types of agar media: standard potato dextrose agar (PDA), a medium of low water potential (SNA) used for growing fungi producing certain types of spores (Nirenberg 1981), a selective medium for "water mold" fungi composed of V-8 juice agar amended with pimaricin, rifamycin, ampicillin, and pentocholonitrobenzene, and a selective medium for *Fusarium* and closely-related fungi (Komada 1975). Plates of all media except those with V-8 juice agar were incubated under diurnal cycles of cool, fluorescent light at about 24 degrees C for 5-7 days.

Figure 1. *Caragana* seedlings with wilt symptoms grown at the Montana State Nursery, Missoula.

Plates with selective V-8 juice agar were incubated at about 24 degrees C for 3 days in the dark. Selected fungi growing from pieces of root tissue were transferred to PDA for identification. Selected *Fusarium* isolates were transferred to carnation leaf agar (Fisher and others 1984) and SNA (Nirenberg 1981) for identification. Taxonomic guides of Domsch and others (1980) and Nelson and others (1983) were used for identification of associated fungi.

Isolation results from wilted *Caragana* seedlings (table 1) revealed that most were infected with *Fusarium* spp. High levels of infection were obtained even though root systems appeared healthy and had little or no necrosis. There was also little evidence of vascular discoloration that might accompany infection with wilt fungi. The major species of *Fusarium* isolated was *F. oxysporum* Schlecht., which can cause wilt diseases of many different types of plants (Armstrong and Armstrong 1975). The other *Fusarium* spp. isolated included *F. solani* (Mart.) Appel & Wollenw., *F. sambucinum* Fuckel, and *F. acuminatum* Ell. & Ev. *Fusarium solani* usually causes cortical root decay on its hosts (Matuo and Chiba 1966). The two other species besides *F. oxysporum*, although commonly isolated from conifer seedlings (James and others 1989b), have not been identified as important pathogens of hardwood tree species, including *Caragana* (Farr and others 1989; Nelson and others 1983). Most of these *Fusarium* species were probably saprophytic on roots of *Caragana* seedlings.

Table 1. Colonization of *Caragana* seedling roots from the Montana State Nursery with selected fungi.

	Percent Colonization	
Fungus	**Seedlings**	**Root Systems[1]**
Fusarium oxysporum	53.8	22.3
Fusarium solani	61.5	28.5
Fusarium sambucinum	30.8	16.1
Fusarium acuminatum	15.4	2.3
All *Fusarium*	92.3	69.2
Phoma eupyrena	69.2	15.4
Alternaria alternata	38.5	19.2
Trichoderma spp.	61.5	13.1
Penicillium spp.	30.7	4.6

1 Intensity of root system colonization based on 10 root pieces sampled per root system.

Other fungi frequently isolated from surface-sterilized roots included *Phoma eupyrena* Sacc., *Alternaria alternata* (Fr.) Keissler, *Trichoderma* spp., and *Penicillium* spp. *Phoma eupyrena* is a common soil-borne fungus that may be associated with tip blight diseases at the Montana State Nursery (James 1986b, 1987b), but is not known to cause wilt of hardwood tree species (Domsch and others 1980). *Alternaria alternata* is a common facultative parasite of a wide range of plants. It most often occurs as a leaf spot on hardwoods, but has also been isolated from the roots and rhizosphere of many plants (Domsch and others 1990). *Trichoderma* and *Penicillium* spp. are common soil-borne saprophytic fungi (Domsch and others 1980), although some *Trichoderma* spp. are capable of being antagonistic toward or competitive with certain soil pathogenic fungi (Papavizas 1985). *Phytophthora cactorum* (Leb. & Cohn), an organism known to cause wilt of *Caragana* seedlings (Farr and others 1989), was not isolated from affected seedlings in this investigation even though it would have grown on the selective V-8 juice agar medium if present.

Soils at the Montana State Nursery are known to often harbor large populations of *Fusarium*. These soil-borne fungi have caused sufficient problems in the past to warrant soil fumigation prior to planting (James 1986a, 1987a). However, such treatments have usually been limited to areas of conifer seedling production where *Fusarium*-associated losses have been most extensive. The field in which *Caragana* seedlings were growing had not been fumigated. Although soil samples were not assayed for fungal populations, it is suspected that levels of *Fusarium* were probably high.

Fusarium diseases, especially those caused by *F. oxysporum*, are most damaging during periods of hot, dry weather (Tint 1945). Such conditions prevailed at the Montana State Nursery prior to appearance of wilt symptoms on *Caragana* seedlings. It is possible that these conditions were conducive to development of wilt-associated disease caused by *F. oxysporum* predisposing seedlings to successful attack by the pathogen. Unfortunately, it is not known if all isolates of

F. oxysporum obtained from *Caragana* seedlings were pathogens capable of inducing wilts. Pathogenic and saprophytic strains of the fungus are morphologically similar (Matuo and Chiba 1966); they can only be separated by either pathogenicity testing (James and others 1989a) or use of biochemical or genetic analyses (Ianelli and others 1982; Kuninaga and Yokosawa 1989). If the isolates were mostly pathogenic, it is likely that much of the wilt was caused by *F. oxysporum* associated with stress conditions on seedlings increasing their susceptibility to disease. Wilt diseases caused by *F. oxysporum* do not often result in extensive decay of root systems (Beckman 1987) such as often occurs when this species attacks conifer seedlings (James and others 1987). Wilting results when the fungus invades vascular systems and causes systemic infections throughout the plant (Beckman 1987). Microconidia are spread via vessel elements to different parts of the plant and multiple infections result. Infected plants continue to deteriorate over time, with wilting continuing even if sufficient moisture is added. Evenutally, infected seedlings will die.

If most *F. oxysporum* isolates were not pathogens, wilting may have been more "normal" because of restricted irrigation during the hottest part of the summer. Even though *Caragana* is extremely drought resistant, there is a point where moisture is needed to replace that lost from transpiration and respiration. If seedlings respond to irrigation by recovering or limiting spread of wilt symptoms, the problem was probably not induced by *F. oxsyporum*.

It is recommended that sufficient irrigation be applied to ensure that seedlings are not wilted due to a shortage of water. If it is confirmed that *F. oxysporum* or some other wilt pathogen is involved, fumigation to reduce soil populations of the fungus may be required. Periodic monitoring for soil populations of *Fusarium* would be necessary to determine if fumigation is needed. Treating affected areas with fungicides once wilt symptoms appear will probably not be effective. It is usually easier to prevent problems from *Fusarium* rather than treat them after they occur (James and others 1990).

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