THE UNIVERSITY OF ARIZONA
Cooperative Extension

Cultural Practices for Karnal Bunt Control

Distribution

Karnal bunt is a disease of wheat, durum, and triticale caused by the fungal pathogen Tilletia indica Mitra. Karnal bunt was first reported in India in 1931, and later in Pakistan, Mexico, the USA, Iran, and South Africa. The disease has been reported in Nepal and Brazil in isolated areas.

Environmental requirements

Karnal bunt requires free water in the soil for teliospores to germinate. The teliospores produce sporidia which are the spores that infect the plant's florets. Cool, cloudy and very humid conditions or rainfall between awn emergence and the end of flowering is required for sporidia production, infection, and for the disease to florish. The incidence of Karnal bunt is usually very low and rarely seen if the environmental requirements are not met. In two years of high incidence of Karnal bunt in the Yaqui Valley of Northwest Mexico, the environmental conditions in March during heading and flowering were: 79ºF average maximum temperature, 50ºF average minimum temperature, 70 to 75% average relative humidity, and 0.24 to 0.50 inches of rain in two to three rainfall events.

Disease cycle

The disease cycle starts with deposition of Karnal bunt teliospores in the soil. Teliospores may remain dormant, but viable for several years. The source of teliospores could have been seed, the wind, animals, contaminated equipment, or other sources. Teliospores located at the soil surface germinate in response to moist conditions and produce sporidia. The plants are susceptible to infection from awn emergence to the end of flowering when sporidia infect the florets and fungal hyphae enter the ovary. Subsequent disease development in the embryo end of the kernel results in the formation of new teliospores which are deposited back in the soil at harvest, adding further to soil inoculum.

Symptoms

Karnal bunt is not easily detected in the field because few florets are typically infected and the area of the kernel affected might be small and facing inwards. A mass of black teliospores is found at the embryo end of the kernel and, at higher levels of infection, along the crease or in the entire kernel. Generally, only a portion of the kernel is occupied by teliospores (partial bunt). Fully bunted kernels will often be destroyed during harvest. A "fishy odor" that may be detectable from heavily infected grain is common to Karnal bunt as well as several other bunt diseases and is caused by aromatic alkaloids present in the spores.

Control

The effectiveness of any control measure for Karnal bunt is questionable since the disease incidence is usually very low or sporadic. Also, as long as zero tolerance for spores or bunted kernels exists, control measures will not solve the problem of Karnal bunt since complete control is unlikely. Nevertheless, control measures can be classified into four broad categories:

Genetic: Development of resistant varieties is most effective long term strategy to minimize disease development.

Chemical: Some foliar fungicides are highly effective against Karnal bunt but none are currently registered for use. Seed treatment is not effective on the current crop since the fungus does not infect seedlings systematically. Furthermore, seed treatments have not been proven to reduce the viability of teliospores.

Crop environment modification: Lowering seeding rate and nitrogen fertilizer amounts and altering irrigation timing are only slightly effective unless taken to extremes where yield potential is jeopardized. Changing the crop environment by delayed planting, however, can be highly effective if rainfall and optimum environmental conditions are avoided between awn emergence and the end of flowering. Unfortunately, delayed planting has the potential for reducing yields. In Northwest Mexico, seeding two rows on 30 inch beds has shown to reduce disease incidence compared to drill seeding. Cultural techniques can suppress disease development but not eliminate the disease.

Soil teliospore reduction: Reduction of teliospore load in the soil by rotating to non-host crops or disinfecting the soil is highly effective but the chances for teliospore re-introduction from other fields is high especially in an area already infested with Karnal bunt spores.

Summary

Environmental conditions between awn emergence and the end of flowering is the overriding factor in disease development. Cultural practices may be partially effective in controlling Karnal bunt but cannot eliminate the disease completely. Karnal bunt is most likely to be found in areas where lodging or water ponding have occurred.

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Effectiveness of various cultural practices in reducing the incidence of Karnal bunt when teliospores are present in the soil. Environmental conditions from awn emergence through the end of flowering are critical for disease development. Certain cultural practices can reduce the occurrence and severity of the disease, but no control measure is likely to eliminate the disease completely. Karnal bunt is most likely to be found in areas where lodging or water ponding have occurred. Zero tolerance for teliospores or bunted kernels can render any control measure ineffective.

Strategy	Cultural Practice	Effectiveness	Comments
Genetic resistance	Variety selection	High	Planting resistant varieties should be an effective long-term strategy to control Karnal bunt. Durum is generally more resistant to Karnal bunt than common wheat, but varieties specifically resistant to Karnal bunt have not been developed. The low incidence and sporadic occurrence of the disease may hamper the development of varieties resistant to Karnal bunt.
Chemical control	Seed treatment	Low	Seed treatments have not been proven to reduce the viability of teliospores. Since Karnal bunt is not a seedling disease and infection occurs near heading, seed treatment is not effective in controlling the disease. Seed treatment is a recommended practice to control other pathogens that may infect wheat seedlings.
	Foliar fungicides	High	Tilt® applied at heading and 1 week later can reduce disease incidence by 90% when environmental conditions are conducive for disease development. However, Tilt® cannot be applied after the ligule of the flag leaf emerges (about 10 to 14 days before heading in Arizona) due to possible illegal residues. Also, the effectiveness of foliar fungicides is questionable where disease incidence is low or sporatic.
Crop environment modification	Planting on light soils	Low	Light soils tend to dry more on the surface than heavy soils, inhibiting spore germination and lowering relative humidity in the crop canopy.
	Delayed planting	Medium	Rainfall between awn emergence and the end of flowering is highly correlated with Karnal bunt incidence. Delayed planting will reduce the chance of rainfall at this critical stage, but could decrease yields.
	Decreased seeding rate	Low	Lower seeding rates facilitate sunlight penetration and air flow in the crop resulting in lower relative humidity and reducing chance for infection.
	Increased row spacing	Medium	Wider row spacing facilitates sunlight penetration and air flow in the crop resulting in lower relative humidity and reducing chance for infection.
	Nitrogen fertilizer rates	Low	Lower nitrogen fertilizer rates result in less succulent plant tissue and a canopy more open to sunlight penetration and air movement.
	Irrigation methods	High	Overhead sprinkling provides optimum conditions for Karnal bunt. Planting on beds may have an advantage since the soil surface on beds tends to remain drier than flat ground.
	Irrigation timing	Low	Avoiding irrigation between awn emergence and the end of flowering when the plants are susceptible to infection may hinder disease development. Unfortunately, this practice may result in yield loss.
	Avoid ponding water	High	The ends of fields and low-lying areas that accumulate water are more likely to be infected with Karnal bunt than other areas of fields. Therefore, effective land leveling and avoiding water ponding may reduce disease incidence.
	Avoid lodging	High	Karnal bunt is more likely to be found in lodged areas where the heads are closer to the humid zone near the soil surface.
Soil teliospore reduction	Planting Karnal bunt-free seed	Medium	Planting Karnal bunt-free seed aids in preventing the spread of the disease. However, Karnal bunt teliospores must be at or near the surface of the soil to germinate and produce sporidia capable of infecting the growing crop. Teliospores planted below the surface with the seed are generally unable to infect the current crop. Broadcasting infected seed offers a distinct chance of depositing teliospores on the soil surface. Since Karnal bunt does not infect the seedling, infected seed can result in healthy plants. Conversely, clean seed can result in infected plants due to teliospores originating from the soil surface which are in position to infect the crop.
	Stubble burning	Medium	Stubble burning can effectively kill teliospores to a depth of 4 inches. However, teliospores can be lifted up in convective currents created by this practice and deposited long distances from the source. Stubble burning as practiced in Mexico as a method of residue disposal has not controlled Karnal bunt.
	Rotating to non-host crops	Medium	Do not follow wheat with wheat and allow an interval of 1 or more years before planting wheat again. Teliospores may survive in the soil for 2 to 4 years or more, while tillage and irrigation may hasten their degradation. Teliospores may be present in the soil despite crop rotation history since contamination is possible from the wind or other sources of spores.
	Plastic mulching or solarization	High	Plastic mulching greatly reduces the ability of teliospores to germinate due to soil heating to a depth of 4 inches.
	Soil fumigation	High	Methyl bromide can reduce teliospore germination by 98% in a wet soil. This treatment is very expensive and generally not allowable.

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