

Rust epidemiology

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There are two basic ways rust diseases start from urediniospores

Local inoculum forming foci

Regional urediniospore spreads

Local inoculum forming foci

Each foci is usually the result of a single urediniospore infection. The oldest infection is low in the canopy. The disease then spreads upward with plant growth and laterally. Thus when the disease appears on the flag leaf the disease foci is about 1 1/3 to 2 meters in diameter. The heaviest infection is near the initial infection site. Spread is down wind and often in a fan shape, and this spread starts following infection at the top of the canopy (flag leaf). Spread may be more than 100 km crop maturity. Until the fan develops it is difficult to do spore trapping studies. Best study techniques involve the use of trap plots. For observation and detection purposes it is desirable to have a minimum of four rows 30 to 100 m in length with 0.3 m between rows. This makes observation easier and provides enough plant material to have a chance to detect rare events. Although single uredinia are nearly impossible to find, as foci develop they are difficult to overlook.

Regional spreads

Initial infections are of the same age, and are randomly spread across an area, which can be as large as a million ha. Initial infections are on the plant tissue at the top of the canopy when infection occurred. This may be within the canopy when sporulation occurs. If an infection is found on the leaf below the flag nearly all infection will be on that leaf etc. If small uredinia are found around (on the same leaf) that would indicate the initial infection was about a month earlier. Trap plots in the USA for regional disease spread should be 4 rows 1/3 m apart and 1.1 m in length. Field observations can be difficult but detection of 1 uredina per 12 m. is possible with trained personnel.

Rod impaction traps (5 mm diam.) 15 cm above the canopy reflected the movement of the urediniospores. We trapped at peak of 125,000 urediniospores per cm² on a single day, in a severe wheat stem rust epidemic at Fargo N.D. Generally in a 45 plus minus day spore trapping season spores per cm² in the hundreds per day with number seasonal total of up to 50,00. Trapping a single spore nearly daily indicated the presence of at least a single uredinium per 12 meter of row. However, number of spores trapped did not closely indicate specific disease severity but a general level of disease. Traps needed to be placed 10 m inside a uniform plot for the most uniform data.

To predict regional disease spread. We used rain samples. Rain was known to remove spores from the air, and it would normally provide favorable conditions for rust infection. Urediniospores are released from the canopy by surface winds and then lifted with thermals to about 3,000 m. and then in our case transported to the NE. Spores are then deposited by the rain drops. A rain of 2.5 mm can clear the air of spores. A funnel of 15 cm diameter was used. If we trapped a single urediniospore nearly always we found rust in the field at a detectable level (1 uredinium per 12 m.) after 14 -21 day. (The terminal velocity of urediniospores is about 1 cm/sec in still air.) Of course we had no immediate way of knowing if the pathogen was virulent on the cultivars being grown.

Aeciospore spreads from alternate host

Initial infections are within a few meters of the host. The taller the host the further the spread. A single alternate host plant results in a point source and the typical fan shape urediniospore spread occurs. Scattered infected alternate host plants results in individual foci around each infected host plant. A row of plants of the alternate host when infected results in a rather uniform spread downwind of the source.