ROOT HEALTH MANAGEMENT FOR DRYLAND DIRECT-DRILLED CEREALS IN THE PACIFIC NORTHWEST

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Wheat and barley historically have been grown with some form of crop rotation, allowing time between these crops for the soil to "sanitize itself." This situation has changed dramatically in recent years, at least for dryland cereals in the Inland Pacific Northwest, where economics have driven growers to plant wheat and barley in the same field every year or at least two out of every three years. Growers have also moved toward greater use of no-till planting as a means to increase their efficiency and reduce soil erosion. Dryland cereals, more than most crops, need a dense, deep-penetrating root system; without this, precious water supplies and nitrogen fertilizer are left unused in the soil, the crop is less able to compete with weeds, and actual yields are only a fraction of the attainable based on the annual precipitation, sunshine, and growing degree days.

The challenge, therefore, has been to come up with ways to manage the soilborne pathogens of dryland cereals while permitting growers to devote half or all of their crop land to production of these crops grown with reduced or no tillage. This challenge is not unlike that faced by growers of crops currently grown with soilborne pathogens and weeds controlled with the aid of methyl bromide. As with most crops, the actual number of root diseases is not large--usually only three or four, depending on the area and year--but even one is enough to put a grower out of business.

For intensive cereals grown with no-till, every effort is made to control volunteer and grass weeds well in advance of planting--to provide a plant-free period of 10-14 days or more to reduce the inoculum potential of the pathogens. With *Rhizoctonia solani* AG8, for example, even a two-week plant-free period (chem fallow adequate to eliminate volunteer cereals and grass weed hosts) prior to direct drilling into standing stubble results in significant control of this pathogen of wheat and barley.

As another practice, loosening the soil with a chisel point in the seed row at the time of planting reduces the inoculum potential of *R. solani* AG8 and the wheat take-all fungus, *Gaeumannomyces graminis* var. *tritici*, by an unknown mechanism referred to as "the soil disturbance effect." As part of this operation, fertilizer and especially the relatively immobile phosphorus is placed directly beneath the seed at the time of planting to offset the loss of absorptive capacity caused by the destruction of roots and rootlets. If the roots cannot reach the nutrients, then the nutrients must be brought to the roots.

Some growers plant cereals as paired rows, rather than in rows spaced uniformly. This provides the same number of rows of the crop in the field but also limits the severity of the wheat and barley root diseases because of greater warming and drying in the top few inches of soil where these pathogens are active. Most soilborne inoculum of the root diseases of wheat and barley exists in the top 4-6 inches of soil and therefore the warming and drying effect needs only to extend superficially to this depth and does not compromise water supplies needed for maximum yield of the crop.

Wheat seed is treated with difenconozole plus metalaxyl for protection against infection of germinating seeds and young seedlings by *Rhizoctonia* and *Pythium* species. This early protection improves seedling vigor, which can also set the final yield potential. There is little or no protection of roots from these pathogens by these or other available seed-treatment chemicals.

The "climax microbiota" present in the rhizosphere of wheat in long-term wheat-monoculture soils and associated with take-all decline includes, consistently, bacteria 1) with ability to produce the broad spectrum antibiotic, 2,4-diacetylphlorglucinol, at 2) a population of more than 10^5 colony forming units per gram fresh-weight of root in the top 4-6 inches of soil. This suppressive soil effect is remarkable, resulting in some cases in very healthy crops in spite of the presence of virulent inoculum of the pathogen and susceptibility of the crop.

So as to make greater use of this natural genetic and biological resource, soil from fields cropped for 15 to 20 years or more to wheat, without a breakcrop, is being used as a source of rhizosphere microorganisms for biological control of wheat and barley root diseases by first screening them for ability to inhibit the target pathogen and then introducing individual or mixtures of select strains applied as a seed inoculation. The strains can be mixed and applied with seed-treatment chemicals. Strains with ability to increase yields by an average of 10-15% are now in the 5th year of field testing.

A highly effective source of resistance has been found to both take-all and Rhizoctonia root rot in a wild diploid relative of wheat and is now being transferred into breeding lines for use in commercial wheats. This resistance has only just been discovered after some 50 years of unsuccessful efforts. This is the latest approach added to the package of approaches available now, about to become available, or still in the early stages of development for management of wheat and barley root health in no-till systems.