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Diagnosis And Management Of Root Disease In Dryland Wheat In Southwest North Dakota

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Abstract

A field demonstration was initiated at four sites in southwest North Dakota to show the effect that root disease has

on yield and quality of wheat grain. Methyl bromide, a fumigant, was used in demonstration plots to control fungal root disease in wheat. Side by side comparisons were made of fumigated and non-fumigated plots. **Methyl bromide is not an economical means of controlling root disease but was used to demonstrate the losses producers experience in the field and to demonstrate what producers can expect if adequate rotations to control root disease were practiced.** Root disease ratings were consistently lower in the fumigated plots than the non-fumigated plots. Fumigated plot yields were 40% greater than non-fumigated plot yields in fields where wheat had been grown three consecutive years and was 26% greater in a field that had a one year break with a non-cereal crop. Test weight and protein, as well, were consistently greater in fumigated plots. Soil nitrate concentrations were found to be greater in the check plots than under the healthy root systems where root disease was controlled.

Introduction

Yields of wheat are often disappointingly low when recropped as wheat after wheat. Yields can be even lower for wheat after wheat grown with heavy surface residues, typical of reduced till or no-till management. Since surface residues save water, and since water is normally limiting to the yield of dryland wheat in southwestern North Dakota, yields should be slightly higher, not lower when planted into standing stubble.

Dryland wheat in southwestern North Dakota is typically grown every other year on fallow or recrop. Either mulch tillage or chem-fallow is used for wheat planted into fallow, but no-till has been used increasingly in recent years for spring wheat and winter wheat with no fallow. Passage of the FAIR act in 1996 has provided opportunities for producers to eliminate fallow and initiate continuous cropping.

Research conducted by NDSU (Stack and McMullen, 1995) and Canadian (Ledingham, et. al., 1973; Mathieson, 1943; Butler, 1961) research scientists has shown that root and crown disease reduce yields between five and ten percent. In continuous cereal and cereal fallow rotations, yields are commonly lower than can be expected based on available soil moisture and growing season precipitation. Cook (1990) found over a 15 year period that when root and crown diseases were controlled with fumigation in continuous wheat rotations, an average 70% yield increase could be expected. A one-year break and a two-year break between wheat crops produced a 22% and 7% yield increase, respectively, for fumigated compared to non-fumigated plots. Rotations which include non-cereal crops for two or three years between cereal crops breaks the disease cycle for cereal root diseases and has been found to be as effective in reducing root disease organisms as fumigation.

Producers are encouraged to incorporate crop rotations into their farming practices. Crop rotations have been shown to reduce problems with insects, weeds, and diseases while improving yields and quality of subsequent crops (Black and Siddoway, 1975). Many producers do not fully realize the extent of yield and quality losses as a result of root and crown disease problems.

This project demonstrated the impact of root disease on dryland wheat in southwest North Dakota and the role that crop rotation can play in their control.

Objectives for this demonstration were: 1) Demonstrate the extent that root diseases affect wheat yields in a continuous and crop-fallow/non-cereal crop rotations; 2) Determine yield and quality gains/losses which are realized through the control of root and crown disease; 3) Demonstrate the use of alternative crops in rotations to control root and crown disease.

Materials and Methods

Four field locations that had a history of either continuous cereal grain or cereal grain with a one-year break of fallow or a crop other than a cereal were selected in southwest North Dakota (Table 1 and Table 2) in cooperation with the county extension agent and producer. A complete randomized block design with four replications at all locations except Beach were used in this demonstration. Three replications were used at Beach. Each treatment within the replication was 300 square feet (28 m^2). Plots to be fumigated were covered with a six mil plastic sheet, edges buried in trenches three to four inches (8 to 10 cm) deep to seal covered area, [Figure 1] and methyl bromide was metered through plastic hoses at the rate of one pound per 100 square feet (50g m^{-2}). The fumigated plots remained covered for 48 to 72 hours after which time the plastic sheet was removed. [Figure 2] Non-fumigated or natural soil plots served as checks. After the plastic was removed, producers farmed through the fumigated and natural soil plots with their normal management practices. **Fumigation is not economically feasible on cereal grains but is used here to demonstrate the losses from root disease in side by side comparisons in the field.**

Root samples were collected from plots when wheat was in the five leaf and soft dough stages of development and sent to the NDSU plant pathology department for analysis. [Figure 3] In addition to what the producer applied in terms of fertilizer, 30 pounds of nitrogen per acre (33.6 Kg ha^{-1}) was broadcast at the five leaf stage in the form of ammonium sulfate on the Amidon, Beach and Regent sites. Yield samples were harvested from each plot by hand from an area four rows wide by eight feet long, bagged, threshed and yield and quality factors determined. Protein was analyzed by Southwest Grain NIR analyzer at Dickinson, ND. In addition to yield sampling, soil samples were taken in six inch (15 cm) increments to a depth of 48 inches (123 cm). Soil samples were analyzed by the NDSU soils lab in Fargo, ND for nitrate. A portion of the soil sample will be washed in spring 1998 and root density calculated using the method developed by Tennant (1975).

Results and Discussion

Yield and Quality

Significant differences in grain yield were detected between fumigated and natural soil plots at Amidon and Beach (Table 3). Fumigated plots at the continuous wheat sites at Beach and Amidon had nearly a 40% increase in yield over natural soil plots whereas a one-year break with sweet clover at the Pick City site, in what was otherwise a continuous cereal grain rotation, saw a smaller yield increase of 26%. Yield differences were greater than expected at the Pick City site. The two preceding crops to the 1997 wheat crop in that field are not known to be hosts to the predominate pathogen *Cochliobolus sativus* (Common root rot). The weed control rating in this set of plots was rated at moderate yet the evidence from nitrate remaining in the natural plot soils would indicate that something other than weeds must be responsible for high rates of nitrate remaining under the natural plots. In 1994 a hail storm went through the area and shattered grain prior to harvest. Volunteer wheat grew in the field in 1995 providing root disease pathogens an opportunity to grow and multiply. Also grassy weeds which may be hosts to root disease have been a problem in the field.

Test weight of the grain at Beach was found to be significantly higher for the fumigated over the natural soil plots. Test weight was greater for the fumigated than for the natural soil plots at both Amidon and Pick City. Grain protein values for the fumigated were always higher than the natural soil plots though protein was very low for both fumigated and natural soil plots at Beach. Nitrogen may have been a limiting yield factor at this site. The site at Regent received rain during the fumigation process which ran off the plastic sheet covered plots into adjacent non-covered areas of the field. This confounded yield and quality results.

Mathieson (1943) and Butler (1961) found that yield and quality factors were affected by root diseases. Cook (1990) indicated that greater or similar losses were experienced in the Pacific Northwest.

Head Density Heading Date and Height

Head density was significantly greater for the fumigated plots compared to the natural soil plots (Table 3). A 60% difference in head density between fumigated and natural soil plots was noted at the Beach, Amidon, and Pick City sites. In addition to the greater number of heads, heading date for plants growing on the fumigated plots was advanced about 3 to 5 days compared to plants growing on the natural soil plots. Cook (1992) suggested that earlier heading was the result of the plant being able to extract greater amounts of phosphorous from the soil through improved root health. Plant height measured at maturity indicated that significant differences occurred at Beach but not at Amidon or Pick City.[Figure 4] *Rhizoctonia* and *Pythium* are root pathogens of wheat known to cause stunting and reduced tillering (Cook, et. al., 1987). [Figure 5]

Root Assessments

The sub-crown internodes taken from natural soil plots were consistently covered by more lesions than from the fumigated soil plots at both the five leaf and soft dough stages of plant development (Table 4). Also the coloration of the roots from the natural soil were darker than those taken from the fumigated soil plots. A visual appraisal of the root mass that was submitted with the sub-crown internode indicated that a greater root mass was attached to the crowns from the fumigated soil plots than from the natural soil plots at two of the three sites.

Culture plate readings conducted by the NDSU Plant Diagnostic Lab indicated that at the five leaf stage of plant development only the common root rot organism, *Cochliobolus sativus*, was present (Table 5). However at the soft dough stage, in addition to finding the common root rot organism, *Fusarium* and *Pythium* were detected at Regent and *Fusarium*, *Pythium* and *Rhizoctonia* were detected at Beach. Common root rot was the only root disease pathogen cultured out from the Amidon site. Cook et. al. (1980) found *Pythium* and *Rhizoctonia* (Cook et. al., 1987) to be more prominent under no-till conditions than in wheat sown under other tillage systems primarily because soils were moister and cooler near the soil surface.

Dried root samples will be washed and root density calculated in the spring.

Soil Nitrate Concentration

More nitrate (Table 6) remained in the natural soil plots than in the fumigated plots at plant maturity. Natural soil plots at Pick City had over four times the nitrate found in the fumigated plots. According to Cook (1992), the reason less nitrate was found under fumigated plots was that plants with healthy root systems absorb more nitrate which would have accumulated in the straw and in grain protein. When excessive soil nitrate is exposed to leaching between crops possible consequences include loss from the root zone for future crop production and the contamination of ground water.

Implications of Demonstration

This report summarizes one year of data. Climatic conditions and crop rotations will affect the severity of disease. Dry conditions will reduce or eliminate the grain yield differences between fumigated and natural soil plots and with higher moisture conditions we would expect greater differences. Inconsistent results can be expected when less than 15 inches (40 cm) of water is available for plant growth (Cook et. al., 1987). Additional demonstrations have been requested by five counties in southwestern North Dakota as well as two counties outside the southwest and the Williston Research Center. Pat Carr, DREC station agronomist, has also requested that this demonstration be conducted on the Dickinson Research Extension Center during the 1998 growing season.

Cooperating Producers

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