# Effect of Crop Residues on Crop Pests, Soil Water, and Soil Temperature

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Much of the wheat acreage in the Southern Great Plains is in a monoculture annual wheat production system. This is very significant when planning crop management strategies, because one of the most useful pest management tools, crop rotation, is unavailable for use. Minimum tillage, or stubble mulch tillage as it was called, has been used by some farmers since the early 1940s. Research with stubble mulch tillage in the '40s and '50s in Oklahoma resulted in wheat yields slightly lower than those in clean-tillage systems. Several reasons were given, including weed control, fertilization, stand establishment, diseases, and insects. Many diseases and insects exist from one crop to the next by remaining on or in the crop residue. One classical way to reduce the prevalence of such pests is to mix the residue with the soil or bury the residue, especially with a moldboard plow.

As no-till wheat production was introduced, the alarm was sounded about increased disease and insect problems. All the residue would remain on the surface for survival of insects and diseases. In 1982, studies were initiated to quantify the severity of disease and insect problems created in no-till compared to other tillage systems. We also monitored soil moisture to a depth of at least 120 cm and soil temperature at 5 cm in these studies.

The most important wheat diseases in the Southern Great Plains are leaf rust, soil-borne mosaic virus, Septoria leaf blotch, and tan spot. Rust only occasionally overwinters in Oklahoma, and tillage practices are of no concern. Soil-borne mosaic virus survives in the soil, and tillage has little to do with its survival. The life cycle of Septoria leaf blotch fungus is not well understood; therefore, the relationship with residue levels left by different tillage systems was unknown. However, the tan spot fungus has a sexual stage which survives on the straw through the summer, matures after some cold treatment, and sporulates in early winter or spring. It was expected that tan spot would be much more damaging where residue was left on the soil surface.

TABLE 1. TILLAGE PRACTICES FOR RESIDUE MANAGEMENT SYSTEMS STUDIES

| System | Residue level | Tillage practices |
|---|---|---|
| Plow | minimal | moldboard plow, disk as needed, harrow, mulch tread |
| Disk | low | disk as frequently as needed, mulch tread |
| Subsurface | intermediate | blade with 6-foot v-blade with treader |
| No-till | maximum | no tillage |

Four tillage systems (Burton and Krenzer 1985) were applied to the same 15 m by 30 m plots year after year (Table 1). The tillage study was conducted at three locations. After the fourth wheat crop was planted, the residue covered 8 percent, 25 percent, 80 percent, and 90 percent of the soil surface in the plow, disk, subsurface, and no-till plots, respectively.

## Greenbug

Greenbug populations (Figure 1) vary from year to year and location to location, but whenever significant numbers of greenbugs were present, we found that the more residue that was present, the lower the greenbug population (Burton and Krenzer, 1985). No other wheat-damaging insect has been present in these plots in high-enough numbers to evaluate, although two are of particular interest: the wheat curl mite and the Russian wheat aphid.

## Tan Spot

Tan spot data has been variable. In some years the more residue left on the surface, the more disease, while in other years there were no differences (Table 2). Since the tan spot fungus produces both sexual (ascospores) and asexual (conidia) spores, more detailed studies were conducted. In one study, 3-m diameter circles were constructed in wheat fields containing no wheat residue. Residue rates of 0, 500, 1,000, and 3,000 kg/ha straw were spread in the circle to establish foci from which to monitor spread of the fungus. Disease development was monitored at 1, 3, 6, and 15 m from the center with the 1-m sampling area being within the residue-covered 3-m diameter circle. Early in the wheat plant development, all tan spot lesions occurred within 3 m of the center of the residue-covered areas (Figure 2). Therefore, the presence of the residue was very important in disease development. The spring of 1985 was extremely dry, and the tan spot did not develop. Gough et al. (1981) reported that significant differences between plow and reduced tillage were obtained in lesions per $cm^2$ leaf area at Feekes growth stage 5 but not at stage 10.4. They believed that the lack of differences was "due to lateral transmission of ascospores." Data from Figure 2 would not support this hypothesis since no lesions were present on leaves only 5-6 m from the residue. Conidia produced

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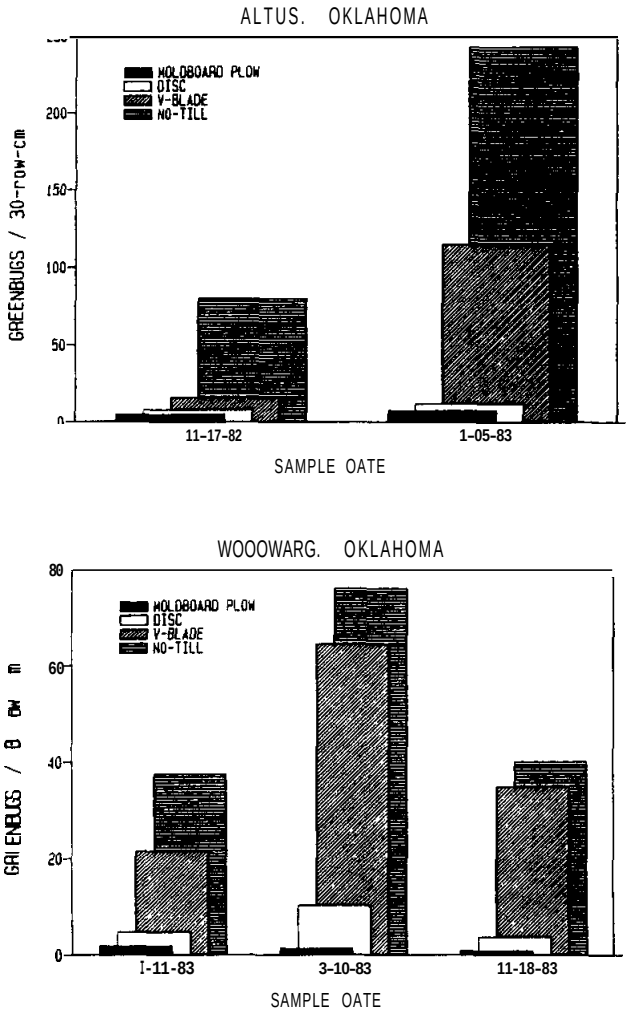


**Figure 1. Effect of tillage practices in wheat plots on greenbug populations at Altus and Woodward Oklahoma. (From: Burton and Krenzer, 1985).**

by the tan spot fungus are wind-borne and have been reported to move up to 50 miles (Hosford, 1976). Conidia are produced in older lesions on lower leaves and act as secondary inoculum. The presence or absence of significant numbers of conidia on older leaves may account for the variability in tillage effect upon tan spot lesions in the flag leaves. Another factor involved may be the favorableness of environment for disease development once the spores are present.

In conclusion, the severity of tan spot does seem to depend upon the presence of infected residue as a source of ascospores for early season infections, but wind-borne conidia are probably the most important later in the season. Since the number of lesions in the flag leaf are most important to wheat yield, the effect of wheat residue may be less important than formerly thought. Further research is needed to verify this.

TABLE 2. EFFECT OF RESIDUE MANAGEMENT ON TAN SPOT PREVALENCE ON WHEAT FLAG LEAVES

| | Location | | | |
|---|---|---|---|---|
| | Altus | | Stillwater | |
| System | 5/23/83 | 5/10/85 | 5/24/84 | 5117185 |
| | lesions/gram leaf tissue | | | |
| Plow | 69 a* | 175 a | 115a | 735a |
| Disk | 92 b | 227 ab | 118 a | 881 ab |
| Subsurface | 110 bc | 276 ab | 117 a | 1364 b |
| No-till | 117 c | 327 b | 143a | 898 ab |

***Lesion numbers followed by the same letter are** not **statistically** different P = 0.05 **according to either an LSD test** or **Duncan.**

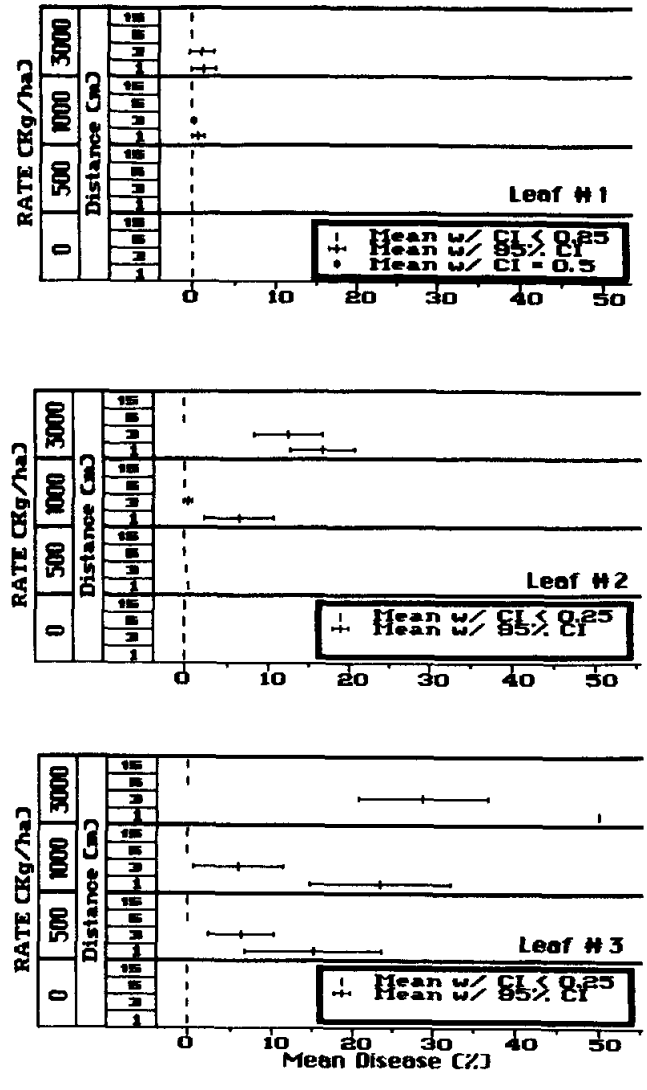


**Figure 2. Tan spot lesions** (12-28-85) **on wheat leaves as influenced** by **residue rate and distance** from **the residue.**

TABLE **3.** THE EFFECT OF TILLAGE SYSTEM ON SEPTORIA LEAF BLOTCH IN WHEAT

| | Location | | | | |
|---|---|---|---|---|---|
| | Altus | | Stillwater | | |
| System | **2/12/84** | **5/10/85** | **5/17/83** | **5/14/84** | **5/17/85** |
| | lesions/gram leaf tissue | | | | |
| Plow | **152** | **15** | **145** a* | **187** | **92** |
| Disk | **224** | **12** | **131** ab | **223** | **67** |
| Subsurface | **213** | 9 | **78** b | **186** | **92** |
| No-till | **225** | **5** | **125** ab | **198** | 93 |
| | **N.S.** | N.S. | | N.S. | N.S. |

***Means followed by the same letter are not statistically different (LSD P=O.O5)**

Septoria blotch

The number of Septoria lesions on the flag leaves has not been statistically affected by tillage in four out of five year locations (Table 3). In the year where differences occurred, there was no trend correlating disease incidence with amount of residue on the soil surface.

Soil Temperature

Soil temperature at 5-cm depth was significantly affected by the amount of mulch left on the soil surface. During late August and early September when farmers are anxious to plant wheat to obtain maximum grazing, the no-till plots were as much as 8 o C cooler at the highest temperature than the plow plots (Figure 3). During Aug. 15-24, 1983, the plow plots did not get cooler than no-till plots. During November on hot sunny days, the plow plots were warmer during midafternoon but colder at night. In early March when regrowth is occurring, the plow plots are warmer during midday, and there were no differences in night soil temperatures (Figure 3). These soil temperature differences may be very important in disease relationships aswell asin plant growth.

Soil Water

The major effect of crop residue on soil water has been to improve the farmers' capability to plant early and obtain a good stand. In two out of six site years, the soil was so dry in August that wheat sown in plow plots did not produce a stand, whereas wheat sown in no-till plots at the same time produced a satisfactory stand. This is probably not a uniquely soil-moisture relationship but probably a combination of soil moisture and soil temperature.

Soil moisture in the rooting profile was seldom affected by tillage systems or mulch levels. This is in contrast to data published from several other states but has been consistent across three locations over four years with neutron scattering moisture monitoring being conducted at least 10 times per season.

## Summary

After four years of evaluating the effects of mulch levels obtained by different tillage systems, pest relationships have not been as negative as expected. No effect of mulch level was observed in the severity of Septoria leaf blotch. On some occasions, tan spot was most Severe where high levels of mulch were present, but in other situations no difference was observed. Greenbug populations were lowest with the highest levels of mulch on the soil surface. Differences in soil temperature were observed among mulch levels, but the differences changed in magnitude and direction depending upon the time of year. Soil moisture differences occurred at planting depth at planting time, but total rooting profile soil moisture differences have Seldom occurred. Overall, the potential for reduced-tillage systems does not appear to be as negative as originally feared.

## Literature Cited

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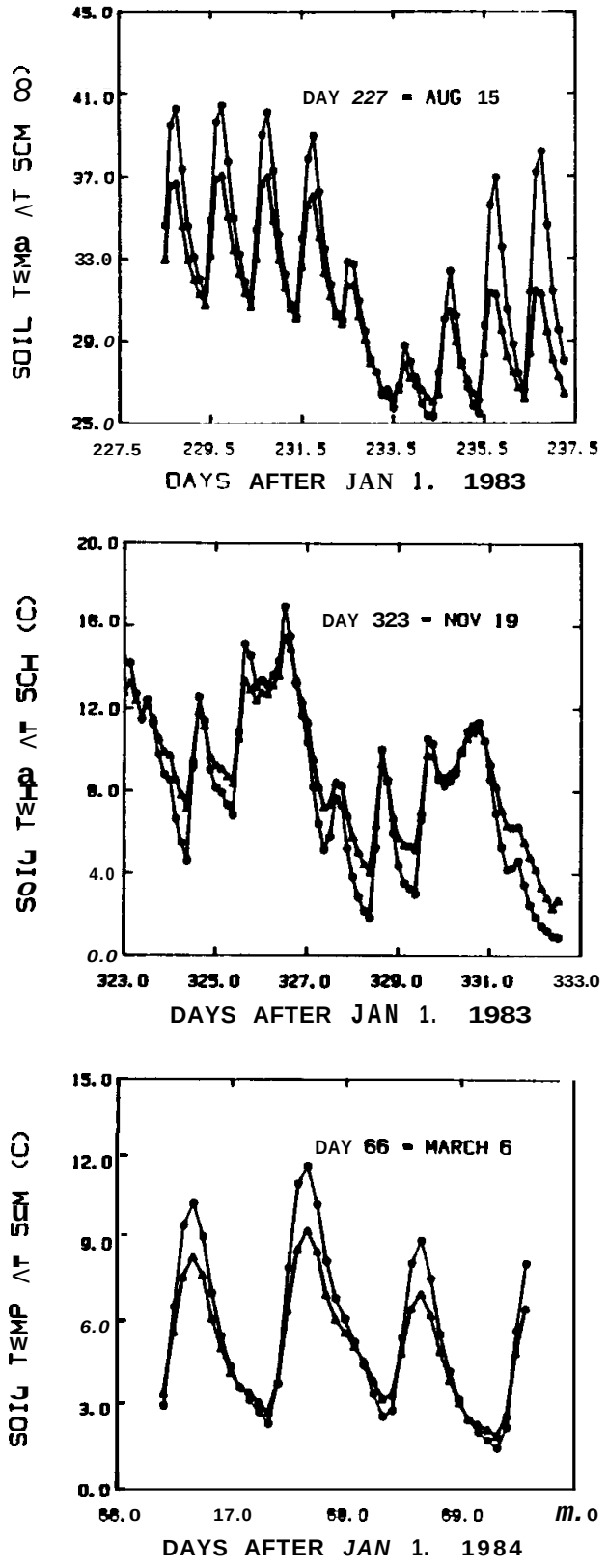


Figure 3. Effect **of** tillage practices and mulch on soil temperature at 5cm at different times during wheat development.