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Yields of Four Spring Wheat Varieties In Conventional, Minimum and No-till Systems

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Erosion on cropland in northern Idaho and eastern Washington is threatening the future of agriculture in this area. The main cause of soil erosion is fall-sown wheat planted into a well prepared seedbed with insufficient seedling growth to protect the soil during winter and spring rainfall runoff events. Soil erosion on the Palouse can be reduced by leaving the soil surface rough or undisturbed during the winter months and by seeding with spring wheat.

The need to reduce soil erosion will cause an increase in minimum tillage and no-tillage management systems in spring wheat production. Changes in tillage systems require reexamination of production practices for growers to obtain maximum yields. The research described here was initiated to examine the effects of conventional tillage, minimum tillage and no-till management systems on grain yield of four, commercially grown, Pacific Northwest spring wheat varieties.

Trial Locations

Field plots were established in two different Palouse environments. One site was on an Athena silt loam near Dayton, Washington, in 1979 and 1980. The average annual precipitation in this area is about 17 inches. In 1980, another set of plots was established on a Palouse silt loam near Pullman, Washington, where the average annual precipitation is about 22 inches.

Tillage Systems

The three tillage systems used were conventional tillage (fall plowing with a spring disking), minimum tillage (fall chiseling or Glencoe Soil Saver with a spring disking) and no-till (direct drilling into standing stubble). Wheat was seeded with a drill equipped with 1-inch wide, hoe-type openers and John Deere HZ split packer wheels. Varieties were seeded at 75 pounds per acre. Previous crops were winter wheat at the Dayton trial and spring wheat at the Pullman trial. Four commercial varieties of soft white spring wheat — 'WS-1,' 'Fielder,' 'Urquie' and 'Walladay' — were compared under the various tillage systems.

Ammonium nitrate (34-0-0) was broadcast over the surface before seeding at a rate of 70 pounds nitrogen per acre. For control of grassy, winter annual weeds and volunteer grain, glyphosate (Roundup) was applied at a rate of 0.75 pound ai per acre over the entire area before seeding. For control of broadleaf weeds, a mixture of bromoxynil and MCPA (Bronate) was applied. Each chemical was used at a rate of 0.50 pound ai per acre when the wheat plants were in the tillering stage.

Results

Tillage Effects

Average grain yields for the spring wheats were 29.5, 34.3 and 34.1 bushels per acre for conventional, minimum and no-till, respectively (Table 1). The overall grain yield for no-till was significantly greater than conventional tillage but not significantly different than minimum tillage.

Table 1. Grain yields of spring wheat for three tillage methods at two locations.

Tillage	Dayton 1979	Dayton 1980	Pullman 1980	Average
		bushels/acre		
Conventional	29.4	29.7	29.5	29.5
Minimum	30.3	33.8	38.7	34.3
No-till	31.5	35.4	35.4	34.1
Average	30.4	32.9	34.5	

Numerous studies have shown considerable variation in yields under no-till between seasons. When examined under ideal conditions, yields under no-till are equal or are sometimes higher than under conventional tillage. When small grains are seeded with a no-till management system into wet soil or when the soil becomes 'waterlogged after planting, emergence is often reduced. Consequently, yields are lower.

More severe weed infestations have also been observed as a cause for reduced yields under no-till. In this experiment, weeds were not a problem since winter annual weeds and volunteer grain from the previous crop were controlled with Roundup. Effective broadleaf weed control was achieved with Bronate. Also, these experiments were performed on well-drained soils where waterlogging was not a problem. The elimination of two major problems associated with no-tilling small grains, weed infestation and poor emergence, could account for a portion of the yield advantage for no-till observed in this experiment.

Another problem associated with no-till is that residue from the previous crop gets forced into the seedrow. This can create an unsatisfactory environment for seedling growth. The hoe-type opener used in this experiment moves the majority of the straw away from the seedrow, thus reducing this problem.

Tillage treatments did not greatly affect yield components. Heads per square foot, seeds per spikelet or seeds per head were similar when averaged across both locations. Several trends were observed, but none was associated with a particular tillage system. For example, the number of seeds per spikelet and seeds per head tended to increase when the number of heads per square foot declined. Apparently, these spring wheat varieties have the ability to adjust their yield components when one component (i.e., heads per square foot) is reduced.

More important are the conditions which result in a significant response to a yield component. For example, early stress conditions associated with no-till, such as cooler and wetter spring soil conditions, can decrease the amount of plant tillering when compared to conventional tillage. On the other hand, no-till systems generally have more moisture in the soil profile during grain filling because of less evaporation caused by the surface residue. Thus, even though a no-till seeded field may appear sparse compared to a conventionally planted field early in the growing season, plants can compensate for this during the head filling stage. This produces equal or higher yields than a conventionally planted field because of more available water.

Table 2. Grain yields of four spring wheat varieties averaged across three tillage systems.

	Dayton 1979	Dayton 1980	Pullman 1980	Average
	bushels/acre			
WS-1	31.6	30.4	44.4	35.4
Urquie	32.2	37.6	39.8	36.5
Fielder	32.9	25.7	21.0	26.6
Walladay	24.8	38.2	32.9	32.1

Variety Effects

Average grain yields for 'WS-1,' 'Urquie,' 'Fielder' and 'Wallady' were 35.4, 36.5, 26.6 and 32.1 bushels per acre, respectively (Table 2). The low yields associated with Fielder were caused primarily by severe stripe rust damage at both the Dayton and Pullman trials in 1980. The other varieties showed only slight stripe rust infestation. During 1979, Fielder was the highest yielding variety because stripe rust was not a problem.

Table 3. Grain yields of four spring wheat varieties averaged across two locations.

Tillage	WS-1	Urquie	Fielder	Walladay	Average
	bushels/acre				
Conventional	32.6	32.3	24.2	29.2	29.6b
Minimum	38.2	40.4	27.1	31.4	34.3a
No-till	35.7	36.8	28.4	35.5	34.1a
Average	35.5a*	36.5a	26.6c	32.0b	

*Values followed by the same letter are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Differences in varietal yields because of tillage systems were observed when averaged across the two locations (Table 3). Urquie and WS-1 averaged the highest yields, and Fielder averaged the lowest yields. Again, average yields were significantly higher under minimum and no-till management than under a conventionally managed system.

The development of all small grain varieties has been under conventional tillage conditions without the stresses of no-till, such as cooler spring soil temperatures, increased weed competition, wetter soil conditions and poor seedling emergence. Currently grown, spring wheat varieties have escaped selection pressure from such factors. Differences in varietal responses to tillage systems shows a need to develop spring wheat varieties for specific tillage conditions.

Future Research

To identify plants that are genetically compatible with the unique environmental factors associated with reduced tillage systems, scientists are switching from testing genetically fixed lines (released varieties) to genetically unfixed lines (early generation crosses). These unfixed lines result early in the breeding program.

Scientists have found that genetically fixed selections have not provided opportunity for the environment to influence the genetic makeup of the lines being tested. They now emphasize earlier selection, usually at the second generation, when genetic factors are only about 50 percent fixed.

The breeding process will accelerate once scientists gain a better understanding of the complex interactions of wheat plants with soil nutrients. These interactions also include other factors such as crop residues, weeds, diseases, insects and weather when grown under minimum tillage or no-till management systems.

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