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SEEDING PEAS AND BARLEY INTO HEAVY CEREAL RESIDUE

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Introduction

Crop residue left on and near the soil surface is the most important factor in soil erosion control during vulnerable periods (McCool et al., 1997), and it helps maintain soil organic matter content (Allmaras et al., 1997). Annual cropping in the Columbia Plateau also reduces soil erosion and helps maintain soil organic matter (Rasmussen et al., 1989), especially with spring seeding. Development of annual cropping systems that maintain surface residue presents challenges for crop establishment. Crop residue on and near the soil surface hinders the seeding operation and crop establishment because residue can plug drills, get tucked into seed furrows, and cause seed depth to be highly variable (Erbach et al., 1983; Hyde et al., 1987; and Wilkins et al., 1992). Crop residue is likely to be wet and tough in the spring, further complicating these seeding problems. This research was conducted to study the effects of heavy cereal residue on drill performance during spring seeding.

Methods

The experiment was located at the Columbia Plateau Conservation Research Center in a field that had produced 100 bu/acre of spring wheat in 1996. Half of the field was tilled after wheat harvest with a heavy off-set disk, having blade diameter of 26 in and implement weight of 150 lb per disk blade. Depth of tillage was 3 to 4 in. The other half of the field was flailed in March to reduce stubble length so that drills would not plug. Before seeding, ammonium nitrate was broadcast on the barley plots at a rate of 80 lb N/acre. In addition, barley received 100 lb/acre of 16-20-0 fertilizer mixed with the seed and metered by the seed boxes. Baroness barley (*Hordeum vulgare* L.*)* at 110 lb/acre (97 % germination), and Aladin peas (*Pisum sativum* L.) (a semi-leafless dry pea variety with 68 % germination) were seeded at 260 lb/acre with four drill types on 2 April 1997.

The experimental design was a split-plot with three replications. Main plots were tillage, and sub plots were the two crops and four drill types. The four drills were a John Deere 9400[1] press drill with 10-in row spacing, Flexi-Coil 5000 air-seeder with Stealth double-shoot hoe type openers spaced 7.2 in apart, a locally fabricated plot-sized air-seeder with Flexi-Coil Stealth spread-tip hoe-type openers spaced 12 in apart, and a plot drill with John Deere tru-vee double-disk openers spaced 7 in apart. Each drill was calibrated to seed identical rates of pea seed or mixture of fertilizer and barley per acre. On the Flexi-Coil 5000 Stealth opener the pea seed and fertilizer/barley mixture were delivered through the bottom exit port (normally used for fertilizer). The target seeding depth was 2 to 2.5 in. This depth was chosen in anticipation of hot, dry weather.

Gravimetric soil water content measurements were taken in the top 4 ft on 14 May. Temperature sensors (Onset Optic Stowaway) were installed 2 in deep in tilled and non tilled areas in the fall and removed prior to seeding. On May 1, pea and barley

[1] Reference to a company name or trade name is for specific information only and does not imply approval or recommendation of a product by the USDA to the exclusion of others that may be suitable.

plants from 3.3 ft of row in each plot were excavated, washed, and the chlorophyll-free length above the seeds measured to determine depth of seed placement. Stand establishment was measured in each plot on 6 May by counting the number of seedlings in 6.6 ft of row. The line transect method was used to determine surface residue cover after seeding. Peas were harvested on 18 July and barley on 1 August 1997. Yield was determined by harvesting approximately 300 ft^2 from each plot with a plot combine.

Results and Discussion

Mean soil temperature at 2 in during March averaged 0.1 °F warmer in the disked plots than in the non tilled plots. This temperature difference was not great enough to influence stand establishment. The mean soil water stored in the top 4 ft was 4.9 in for disked and 5.8 in for non tilled plots. This difference in soil water was statistically significant ($P \leq 0.01$). Reduced evaporation and increased snow entrapment probably caused the increased water storage in the non tilled plots. This additional inch of soil water in the non tilled plots would be expected to result in higher pea and barley yields.

Table 1 presents the influence of tillage and Table 2 presents the influence of drills on barley seedling depth, stand establishment and grain yield. There were no significant interactions between tillage and drill type for measurements taken in the barley plots. Fall disking did not improve stand establishment. The additional inch of soil water in the non tilled plots did not result in a significant increase in yield, but there was a trend in that direction. Ninety percent of the surface was covered with residue in direct seeded plots compared to 45 % in plots that were disked.

The type of drill used influenced barley seedling depth and stand establishment. The hoe-type openers placed seed deeper into the seedbed than did the double-disk openers. The disk drill did not have sufficient weight to force the disk openers into the soil, and consequently seed was placed about 1 in or less deep rather than at the target depth of 2 to 2.5 in. Cool, moist conditions followed seeding, and in a moist seedbed the optimum barley depth is one inch. Seedling establishment was therefore higher in the plots seeded with the disk drill than in plots seeded with the hoe drills. Note that a drawback of determining seed placement by measuring the chlorophyll-free length is that only successfully emerged seedlings are counted. Non emerged seedlings are ignored, and these seeds are more likely to be very deep or very shallow.

Barley yields ranged from 5020 to 5330 lb/acre in plots seeded with the different drills. These differences were not statistically significantly ($P \leq 0.05$). Although the yield differences were not significantly different, plots seeded with the John Deere 9400 press drill and the Flexi-Coil 5000 yielded less. This yield difference may have been due to greater compaction over the seed rows by these drills.

In the pea study there was a significant interaction between tillage and drill type, and therefore the data are summarized in a single table (Table 3). Maximum seeding depth for the disk drill was slightly over 1 in, but many seeds were placed shallower than 1 in. These seeds may have started to germinate but died before roots could be established into moist soil. The high amount of crop residue in the non tilled plots caused the disk openers to ride out of the soil occasionally; therefore, fewer seeds were placed into moist soil than in the tilled plots. Several seeds were observed on the soil surface in non tilled plots seeded with double-disk openers. This lack of consistent opener penetration resulted in 4.8 plants/ft^2 in non tilled plots compared to 10.0 plants/ft^2 in the fall-tilled plots. These results are consistent with earlier tests that showed double-disk openers do not penetrate non tilled soil (Lindwall and Anderson, 1977; Wilkins et al., 1992). Cool, moist conditions followed seeding, and if the weather had been hot and dry it is doubtful any stand would have been established in plots seeded with disk openers.

In both the tilled and non tilled plots, the best pea yields occurred in plots with the best stands. It is interesting to note that wider row spacing produced lower yield in the tilled plots and the opposite was true in the non tilled plots. Because row spacing was confounded with drill type, in these studies, differences in yield may have been due to row spacing, drill type or a combination of both. It is possible that the effect of row spacing may not be as important in direct seeded fields as in tilled fields. Three of the four drills produced higher pea yields in tilled plots than in non tilled plots even though the non tilled plots had an inch more stored water.

Conclusions

Seeding spring peas and barley into heavy wheat stubble is possible with seeding equipment designed for intensive tillage systems when the stubble length is reduced by flail mowing or by tilling with a heavy off-set disk after wheat harvest. In soil tilled once in the fall and again with moist spring conditions, the shallow seeding of conventional double-disk openers produced better stands of barley and peas than did the deeper seeding of the hoe-type openers. In non tilled seedbeds, good barley stands were obtained with conventional double-disk openers when the surface soil (top 1 in) remained moist during germination and emergence. Pea stand establishment was not adequate when conventional double-disk openers were used in non tilled soil because disk openers did not penetrate the soil sufficiently. Direct seeding into wheat stubble either tilled once or fail mowed in the fall resulted in barley yields exceeding 5000 lb/acre and pea yields exceeding 2500 lb/acre.

Table 1. Effect of tillage on residue cover, seedling depth, stand establishment, and yield of barley, averaged over all drill types, Columbia Plateau Conservation Research Center, Pendleton, OR, 1997.

Tillage	Residue	Seedling Depth	Stand	Yield
	%	in	plants/ft²	lb/ac
Fall Disk	45 a*	2.5 a	17.3 a	5110 a
Direct Seed	90 a	2.0 a	17.2 a	5290 a

*Means within a column followed by the same letter are not significantly different as determined by the F test (*P*≤ *0.05*).

Table 2. Effect of seeding equipment on residue cover, seedling depth, stand establishment, and yield of barley, averaged over both tillage treatments, Columbia Plateau Conservation Research Center, Pendleton, OR, 1997.

Drill	Surface Residue	Seedling Depth	Stand	Yield
	%	in	plants/ft²	lb/a
John Deere 9400	66 a*	2.3 b	13.9 b	5040 a
Flexi-Coil 5000	68 a	2.5 b	16.2 b	5020 a
Plot Air-Seeder	75 a	3.2 a	16.6 b	5410 a
Plot Disk Opener	71 a	1.0 c	22.7 a	5330 a

*Means within a column followed by the same letter are not significantly different as determined by the LSD test (*P*≤ *0.05*).

Table 3. Effect of seeding equipment on seedling depth, stand establishment, and yield of pea, Columbia Plateau Conservation Research Center, Pendleton, OR, 1997.

	Disk Tillage			No Tillage		
Drill	Seedling Depth	Stand	Yield	Seedling Depth	Stand	Yield
	in	plants/ft²	lb/a	in	plants/ft²	lb/a
John Deere. 9400	2.9 b*	8.7 ab	2720 ab	2.8 ab	10.1 a	2580 a
Flexi-Coil 5000	2.7 b	9.0 ab	3020 ab	2.5 b	6.8 bc	2410 a
Plot Air-Seeder	3.6 a	6.8 b	2570 a	4.1 a	8.2 ab	2580 a
Plot Disk Opener	0.9 c	10.0 a	3070 b	1.0 c	4.8 c	1830 b

Means within a column followed by the same letter are not significantly different as determined by the LSD test ($P \leq 0.05$*).

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