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EFFECTS OF SEEDING DATE ON YIELD, WATER USE, AND DISEASE OF WINTER AND SPRING WHEAT CULTIVARS

Chengci Chen, William A. Payne, Richard W. Smiley,
Lisa M. Patterson, and Karl E. L. Rhinhart

Introduction

Seeding date strongly influences the environmental conditions encountered by wheat plants, including temperature, formation of soil crusts, water availability, and atmospheric evaporative demand. All of these influence emergence, growth, development, water use, and timing of drought for the wheat plant, and therefore influence crop yield. Therefore, optimum seeding date is usually a prerequisite for optimum yield. Because wheat varieties respond differently to environmental conditions such as drought or cold, they may have different optimal seeding dates.

The presence and severity of several important wheat diseases also are affected strongly by seeding date. Diseases such as Fusarium foot rot, strawbreaker foot rot, Cephalosporium stripe, and barley yellow dwarf are most damaging when winter wheat is seeded early in the fall, between late-August and mid-September. On the other hand, diseases such as Pythium root rot and Rhizoctonia root rot are usually most damaging when winter wheat is seeded late in the fall, between late-October and early-December. Just as wheat varieties respond differently to the environment, they also differ in susceptibility to these diseases.

The objective of this study was to evaluate the effects of seeding date on yield, water use, and disease incidence of several winter and spring wheat cultivars.

Materials and Methods

The study was initiated in 1995 at the Columbia Basin Agricultural Research Center of Oregon State University, Pendleton, Oregon. Beginning in 1997, crop water use was monitored using neutron probes to measure soil water content. In this paper, results of yield and water use in 1997-1998 and 1998-1999 cropping years are reported. Disease information reported in this paper includes data from the experiments conducted in 1995, 1996, and 1998. Six winter wheat cultivars (Stephens, Rohde, Gene, Madsen, Rod, and Temple) were seeded on seven dates between 5 Sept. 1997 and 18 Mar. 1998. Two spring cultivars (Alpowa and ID485) were sown with winter cultivars on five dates between 10 Oct. 1997 and 18 Mar. 1998. The soil at the study site is Walla Walla silt loam (coarse, silty, mixed mesic Typic Haploxeroll). Fields were summer-fallowed the previous year. Plots were 10 x 30 ft, replicated four times, and completely randomized for each seeding date.

Wheat was seeded at a rate of 18 seeds per square foot for the first two seeding dates using a John Deere HZ splitpacker plot drill with a 14-inch row spacing. A rate of 26 seeds per square foot was used for the remaining 5 seeding dates, using a Hege 55 plot drill with double disc openers on a 6-inch spacing. The John Deere plot drill was used for the first two seeding dates because the John Deere HZ drill can plant seeds deeper to reach moisture at early seeding dates when surface soil is dry. Before sowing, fertilizers were applied as solutions of anhydrous ammonia and ammonium polysulfide at rates of 100 lb N/a and 10 lb S/a using a PGG 22-2 "Raven" shank applicator. Starter fertilizer (16:20:0:24) at 60 lb/a was applied with seeds for the February and March seeding dates.

Soil water content was measured periodically for three winter (Stephens, Madsen, and Temple) and two spring (Alpowa and ID 485) cultivars in 1997-1998, and for two winter (Stephens and Madsen) and two spring (Alpowa and ID 485) cultivars in 1998-1999. Soil water content was measured using a neutron probe Model CPN 503DR (CPN Corporation, Pacheco, CA). One neutron probe tube was installed in the center of each plot. Soil water content was measured in 6-inch increments for the first 2 feet, then 1-foot increments down to 5 feet, depending on the depth of the soil profiles.

Disease incidence and severity were evaluated on 20 plants in each plot during spring. Special attention was given to symptoms of Fusarium foot rot (lesions on subcrown internodes, or rotting of crowns), strawbreaker foot rot (lesions on stem bases), Cephalosporium stripe (yellow stripes on leaves, with associated vascular discoloration), take-all root rot (blackening of vascular tissue in seminal roots), Rhizoctonia root rot (rotting and "spear-tipping" of crown roots), and root lesion nematode (deterioration and discoloration of root cortex, and reduced branching). Determinations were made for percentages of plants with symptoms, except that strawbreaker foot rot was reported as percentages of affected tillers rather than plants.

Statistical analysis was performed with STATGRAPHICS Ver.7.0 (Statistical Graphics Corporation, 1993). Yield and soil water data within each seeding date were analyzed using ANOVA, and then the differences between varieties were compared using LSD (P=0.05).

Results and Discussion

In the 1997-1998 cropping year, highest yields were obtained from seeding dates from October to November (Figure 1). The mean yield of September-seeded wheat was 17 bushels less than October seeded ones. Yield of winter wheat seeded after February declined sharply due to lack of vernalization. All six winter varieties followed similar trends.

In the 1998-1999 cropping year, the highest yield was produced by the 5 October seeding date. Yield of winter wheat seeded in September tended to be lower than that seeded on 5 October. Yield declined for all six winter wheat varieties seeded after 5 October (Figure 1). Decreased yield of winter wheat with delayed seeding date also was reported in Saskatchewan (Fowler, 1983) and in the midwestern United States (Dahlke et al., 1993).

There was little difference in yield among varieties for 1997-1998 compared to the 1998-1999 cropping year (Figure 1). In 1997-1998, all six varieties performed equally well, producing 76 to 87 bushels on the seeding dates between October to November, except Rohde which had significantly lower yield (70 bu/a) on the 10 October seeding date (P<0.05). There was relatively less effect of early seeding dates on yield of Madsen in comparison to other varieties.

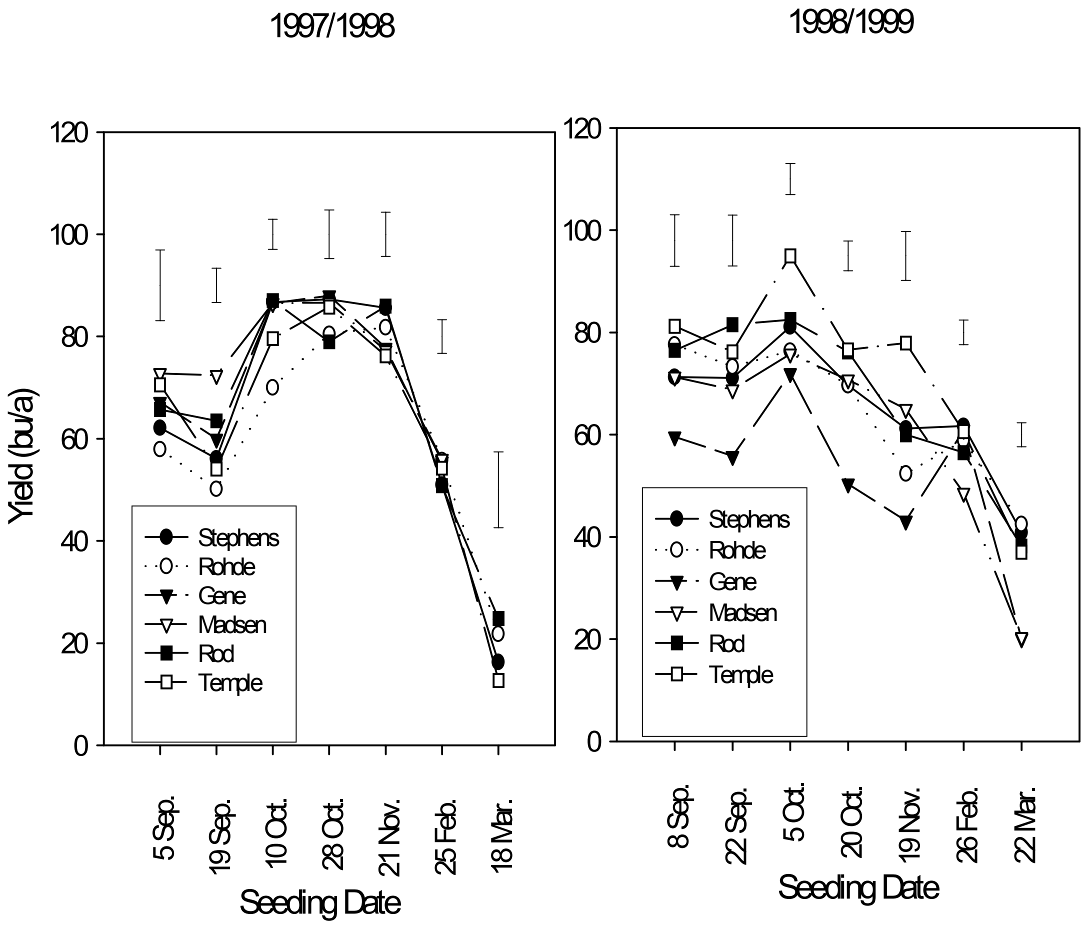

Figure 1. Yield of six winter wheat varieties in 1997-1998 and 1998-1999 cropping years. The error bars next to the data points represent ± 1 SE.

In 1998-1999, however, Temple performed better than other cultivars, producing significantly higher yield on the 5 October seeding date ($P<0.05$). Gene performed relatively poorly, producing significantly lower yield than Rod and Temple in all the seeding dates from September through November ($P<0.05$). In 1998-1999 (Figure 1), there was relatively less effect of early seeding date on yield of Rohde, Madsen, and Rod. In 1998-1999, the spring rainfall was lower than that in 1997-1998. It was 3.25 inches from 1 April to 30 June of 1998, and 4.07 inches in the same period of 1999. Winter wheat might have experienced more severe terminal water stress in 1998-1999. Yield differences may relate to differential drought tolerance of the varieties.

Spring wheat seeded in winter, particularly before November, had unstable yields (Figure 2). March-seeded spring wheat tended to have slightly lower yield compared to February seeded (little change for Alpowa in 1998-1999). Yield decline associated with delayed sowing was not as much as with winter wheat (Figures 1 and 2). Spring wheat seeded in February and March had lower yields than the winter wheat seeded in early October (Figures 1 and 2).

Early-seeded winter wheat tended to have greater amount of water remaining in the soil profile after harvest (Figure 3) despite the fact that yields tended to be greater for October-seeded than late seeded wheat (Figures 1 and 2). There were similar

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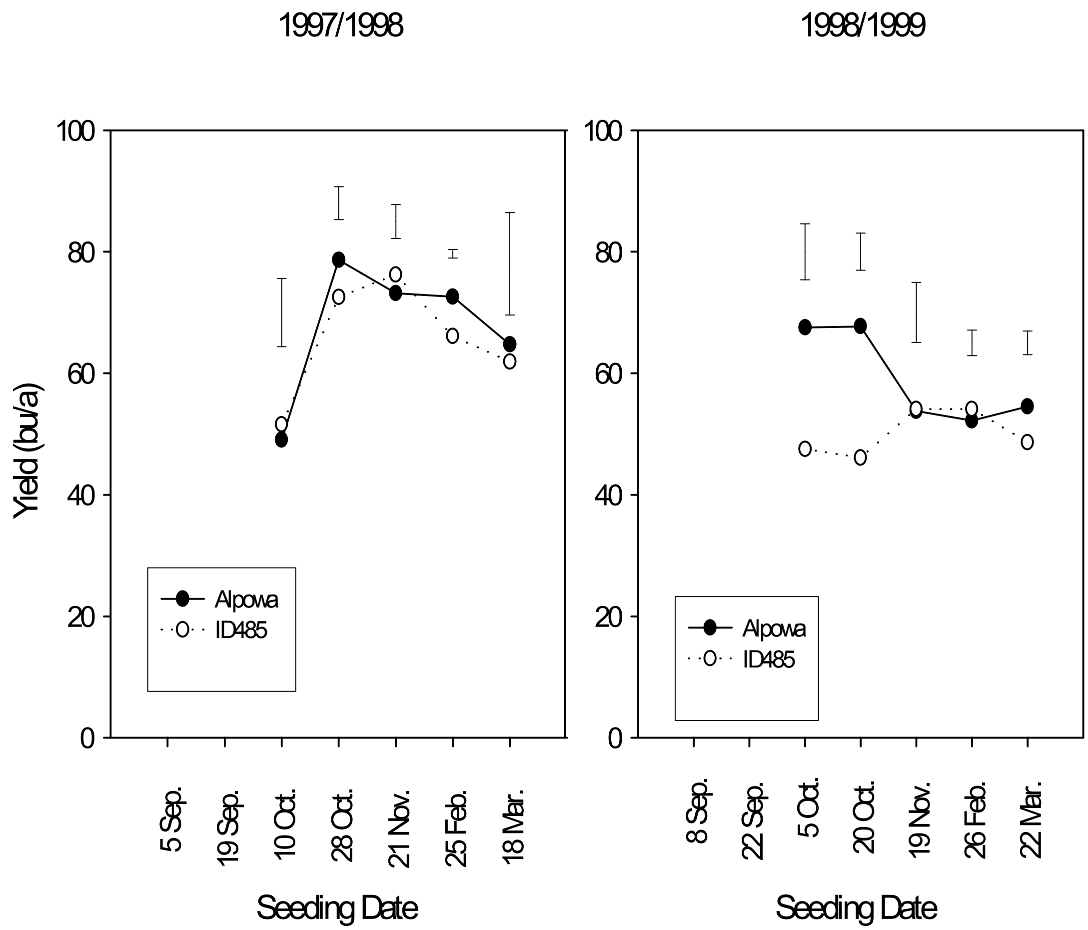

trends in 1997-1998 and 1998-1999 (Figure 3). These data suggested that early-seeded winter wheat could make more effective use of fall rains than late-seeded wheat. They also reached maturity earlier, and thereby tended to avoid terminal drought. February- and March-seeded winter and spring wheat were dependent solely on soil stored water in the late growing season due to the lack of spring rainfall. October-seeded winter wheat varieties had about 1 inch more water remaining in the soil profile than February-seeded spring wheat varieties in the 4-feet-deep soil profile in 1997-1998, and the winter wheat produced 20 bushels more grain than spring wheat (Figure 1,2, and 3).

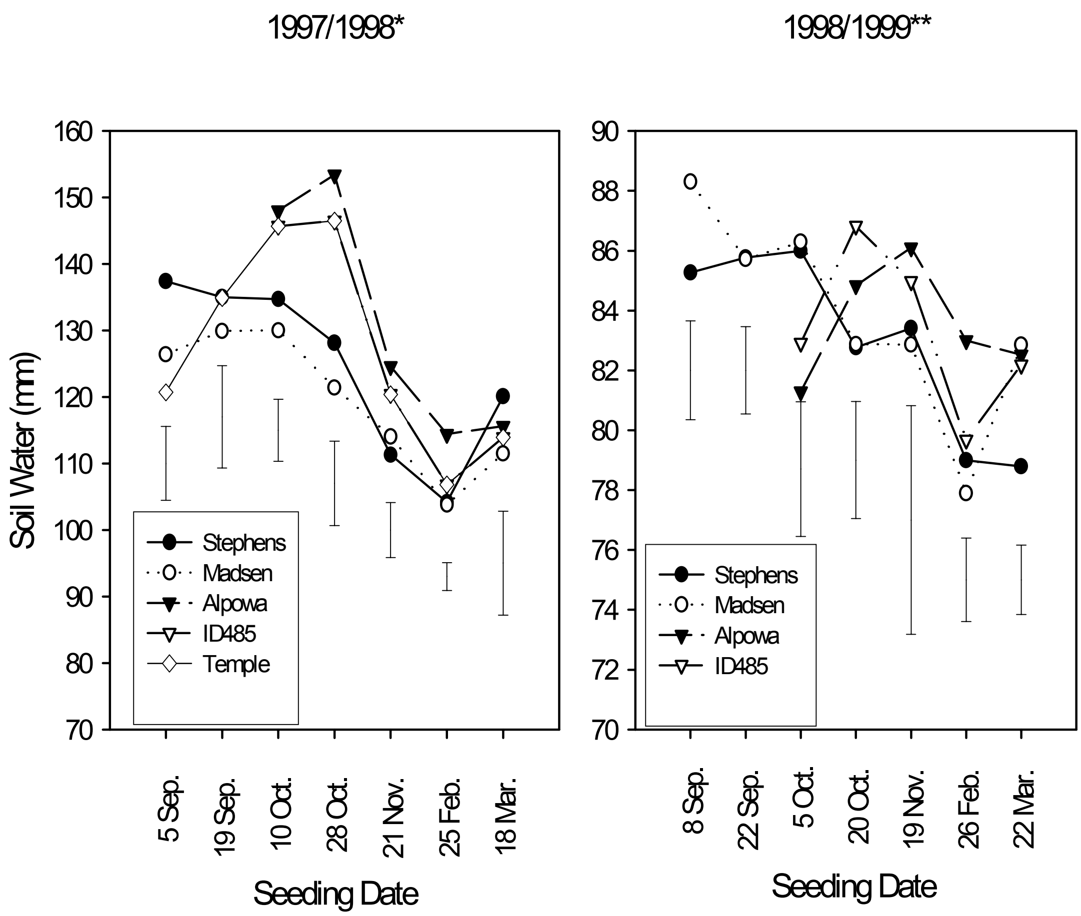

Figure 3. Water remaining in the soil profile after harvest for winter and spring varieties in 1997-1998 (*in 4-feet soil profile) and 1998-1999 (** in 3-feet soil profile) cropping years. The error bars next to the data points represent ± 1 SE.

Decreased yields observed for the first two early seeding dates of winter wheat may be related to disease incidence. Tables 1 and 2 show disease incidence for several varieties as affected by seeding dates during the years 1995, 1996, and 1998. Fusarium foot rot, strawbreaker foot rot, and Cephalosporium stripe generally became less damaging as seeding dates were delayed.

During 1998-1999, Fusarium foot rot was very prevalent, but strawbreaker foot rot was absent. In 1998-1999, take-all severity ratings and percentages of plants affected were high for all dates. Rhizoctonia root rot severity was low to moderate in these trials, even when high percentages of plants were affected. Percentages of plants with Rhizoctonia root rot increased with delay in planting until the 20 October, and then decreased, possibly in response to the rains in November. Root lesion nematode incidence also became more severe as planting was delayed.

Conclusions

The optimum seeding date for winter wheat was mid-October. The October seeded winter wheat produced a higher yield and had a greater amount of water remaining in the soil profile after harvest than late seeded winter wheat. The decreased yield of early-seeded wheat may be associated to disease infection. Disease (e.g., Fusarium foot rot) was more severe in winter wheat seeded before October. The optimum seeding date for spring wheat was late February, although the spring wheat may survive and produce acceptable yield when it is sown in mid-November in this area. Winter wheat seeded in October produced a higher yield and left more water in the soil profile after harvest than spring wheat seeded in February and March.

References

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Table 1. Influence of seeding date on percentages of plants or tillers with symptoms of six diseases on a single representative winter wheat variety.

Variety, disease present	Seeding date in 1995				Seeding date in 1996				Seeding date in 1998				
	8 Sep	21 Sep	11 Oct	30 Oct	3 Sep	20 Sep	10 Oct	2 Nov	8 Sep	22 Sep	5 Oct	20 Oct	19 Nov
Variety:	Rod				Stephens				Stephens				
Percentage of plants affected:													
Fusarium foot rot	57	62	0	0	36	27	27	0	65	73	7	7	7
Strawbreakerfoot rot †	51	21	0	0	7	34	14	8	-	-	-	-	-
Cephalosporium Stripe	-	-	-	-	23	14	5	8	-	-	-	-	-
Take-all root rot	17	17	0	0	-	-	-	-	100	100	93	80	79
Rhizoctonia root rot	69	78	74	56	-	-	-	-	21	47	57	87	39
Root lesion Nematode	-	-	-	-	-	-	-	-	7	13	0	67	62

† percentage of tillers

Table 2. Influence of seeding date on percentages of plants or tillers with symptoms of three diseases on six winter and spring wheat varieties.

Percentage of plants or tillers with symptoms of:	Seeding date (1996)			
	3 Sep	20 Sep	10 Oct	2 Nov
Fusarium foot rot				
Stephens	36	27	27	0
Rohde	29	37	29	0
Madsen	50	42	27	0
Strawbreaker foot rot †				
Stephens	7	34	14	8
Rohde	8	30	21	8
Madsen	8	12	1	1
Cephalosporium stripe				
Stephens	23	14	5	8
Rohde	14	13	6	6
Madsen	11	15	7	6
Gene	23	17	8	16
Alpowa	-	-	5	16
ID 485	-	-	12	17

† percentage of tillers.