IWC Annual Report

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Title: Planting Dates, Seeding Rates, and Available Moisture for Dryland Winter Wheat Yields
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Abstract:

Seeding rate and seeding date are important components of fall-seeded dryland wheat production in southern Idaho. Insufficient moisture at the time of planting or having too many plants utilizing limited water resources may negatively impact the yield potential of dryland wheat fields. The objectives of this study were to evaluate the effect of dryland winter wheat planting date and seeding rate on soil moisture availability, nitrogen use efficiency, and grain quality and yield and 2: Assess the relationship of available water and spring rainfall with dryland winter wheat grain yield. In 2022, earlier planting dates resulted in greater plant available water whereas planting in August lacked adequate surface soil moisture for wheat seeds to germinate. Despite having greater available soil moisture in July, earlier seeding resulted in poorer yields relative to August or September seedings. If grain was seeded in October, higher seeding rates are recommended to improve yield potential. These results support the current University of Idaho recommendations for dryland winter wheat production.
Due to harsh winter conditions, all eight on-farm winter wheat trials winter killed and were either left fallow or reseeded to spring wheat or spring barley. We continued the on-farm trial experiments, only evaluating spring wheat. Seven additional on-farm winter trials were established for the 2023-2024 growing season and will be evaluated in the coming months.

Background/Objectives:

Water is the most limiting factor for dryland winter wheat production in Southeastern Idaho. Its availability affects producer decisions regarding planting date, planting rate, seeding depth, and fertilizer rates. In Southern Idaho, annual precipitation ranges from 10 to 20 inches, with approximately half occurring from October through March (https://www.usbr.gov/pn/agrimet/currentdata.html). Current predictions estimate that southern Idaho will become warmer with drier summers and wetter winters. Dryland winter wheat producers must make the majority of their agronomic management decisions before they know what the environmental conditions will be for the coming growing season. One strategy to help minimize risks and to manage input costs is to develop yield-water relationships that take into account stored soil water just before planting and the expected growing season precipitation[3]. Two other management decisions that can affect available soil moisture are planting date and seeding rate. Dryland winter wheat needs to be planted early enough to allow for tiller and crown development and adequate root growth before winter dormancy. The current Southern Idaho dryland wheat production guide recommends planting in mid-August to early September. However, because wheat seedlings require 2.3 inches of available water from germination through tillering, some producers may plant immediately following a rain event as early as July to take advantage of available moisture. Planting too early can produce large plants that deplete soil moisture and expose the crop to potential disease and insect problems. In contrast, planting too late can reduce the number of tillers formed and delay the transition from vegetative to reproductive development. Hot temperatures during reproductive development can reduce spikelet and floret numbers and impair kernel set.

Seeding rates that are too low for a given set of environmental conditions produce reduced yields and may have higher weed pressure due to lack of crop competition. In contrast, seeding rates that are too high produce excessive vegetation that exhausts soil moisture, reduces tiller number per plant, may increase disease potential, and negatively impact yield.

The objectives of this study were to 1: Evaluate the effect of dryland winter wheat planting date and seeding rate on soil moisture availability, nitrogen use efficiency, and grain quality and yield and 2: Assess the relationship of available water and spring rainfall with dryland winter wheat grain yield.

Results / Accomplishments:

Objective 1:

A pseudo dryland field experiment was established in the summer of 2022 and the summer of 2023 at the Aberdeen R&E Center. The study was a split-plot design in 2022 and a randomized complete block design in 2023. UI Sparrow (soft white winter wheat) was planted at one of four planting dates occurring the third week of July, August, September, and October and the split plots were four pure live seeding rates of 300K, 500K, 700K, and 900K seeds per acre replicated four times (64 total plots). Aberdeen annually receives 7.6 inches of precipitation compared to Grace, Ririe, Ashton, Preston, and Tremonton which receive an annual average of 14.4 inches. Three to five inches of irrigation was supplied before study initiation in May and June to artificially increase soil available moisture to be similar to other southern Idaho dryland sites. The field was chemically fallowed until planting. A composite soil sample was taken from each replicate at 1-foot increments down to three feet and analyzed for nutrient status in July. Immediately before each planting event, soil samples were collected from each main plot at the 0-6, 6-12, 12-24, 24-36, and 36-48” depths and analyzed for gravimetric water content. The soils were dried, ground, and analyzed for inorganic nitrogen content. In the spring after planting and in August after harvest, soil samples were taken from each plot at the 0-6, 6-12, 12-24, 24-36, and 36-48” depths and analyzed for gravimetric water content and inorganic nitrogen content. The soil bulk density will be used to convert gravimetric water content to volumetric water content. Additional plot measurements include stand count, tiller number, lodging, insect and disease ratings, grain yield, and other yield metrics (test weight, grain protein, etc.). Whole plant tissue nitrogen will be measured from each plot at harvest. The response of the dependent variables to planting date and seeding rate is being/will be assessed using analysis of variance.

Volumetric Water Content at Planting								
	0-6"		6-12"		12-24"		24-36"	
July	0.1127	A	0.166	A	0.2414	B	0.4031	A

August	0.09936	AB	0.1453	B	0.2535	AB	0.3123	B
September	0.109	A	0.1478	B	0.2958	A	0.2345	C
October	0.08529	B	0.1085	C	0.1755	C	0.259	BC
Effect	**Pr > F**							
Month	0.0078		<0.001		0.0015		0.0004	
Within planting depth, means followed by the same letters are not significantly different at P<0.05.								

As was expected, earlier planting dates had greater available soil moisture at all soil depths. Soil moisture moves up and down through the soil profile in response to precipitation, irrigation, and evapotranspiration. As the water evaporated from the soil surface, soil moisture in the deeper depths moved up the soil profile, depleting soil moisture reserves in the deeper depths as was observed at the 24-36" depth from July through October. Inadequate moisture in the top 2-3" inches can prevent the crop from emerging. For example, the August seeded grain did not have adequate moisture to germinate and did not sprout until September rains fell. Thus the emergence of the August seeded grain was within 1-2 weeks of the September seeded grain. While fall-seeded wheat should put forth adequate growth in the fall to develop at least two tillers, wheat can still successfully vernalize and produce grain even if the grain has only developed a small shoot. The winter of 2023 was extremely harsh and caused significant winter-kill to wheat fields across southern Idaho. Many of the winter wheat fields were replanted to spring wheat. We likewise observed significant winter-kill in our studies. Many of the wheat plants that had put forth good growth and tillers in the fall did not survive the winter. Whereas, wheat seeds that had barely germinated in the fall emerged in the spring. In this study, irrespective of seeding month the 300K, 500K, and 700K seeding rates had spring stand counts of 7.2 plants per square foot whereas the 900K rate had 10.6 plants per square foot.

Volumetric Water Content measured on May 18, 2023

Month	Seeding Rate	0-6"	6-12"	12-24"	24-36"	36-48"
July	300000	0.1464	0.1488	0.265	0.2477	0.3951
July	500000	0.1478	0.1821	0.2624	0.3563	0.4104
July	700000	0.1539	0.1608	0.2598	0.322	0.3685
July	900000	0.1509	0.1644	0.2241	0.2579	0.3118
August	300000	0.1312	0.1813	0.2246	0.2504	0.3109
August	500000	0.0992	0.1528	0.2005	0.2461	0.2782
August	700000	0.1401	0.1692	0.2217	0.3166	0.295
August	900000	0.1403	0.1615	0.2203	0.2215	0.2365
September	300000	0.1491	0.1928	0.2241	0.2535	0.3561
September	500000	0.1217	0.1407	0.2328	0.3119	0.3881
September	700000	0.1433	0.1811	0.2279	0.278	0.2855
September	900000	0.1185	0.163	0.2226	0.2446	0.3255
October	300000	0.1792	0.2047	0.2514	0.3306	0.4122
October	500000	0.1243	0.1927	0.2754	0.3626	0.4111
October	700000	0.1208	0.1616	0.2481	0.293	0.3588

October	900000	0.1409	0.1935	0.2092	0.3114	0.4843
	300000	0.1514A	0.1819	0.2412	0.2705	0.3685
	500000	0.1232B	0.1670	0.2427	0.3192	0.3719
	700000	0.1395AB	0.1681	0.2393	0.3024	0.3269
	900000	0.1376AB	0.1706	0.2190	0.2588	0.3395
	Average	0.1379	0.1719	0.2356	0.2877	0.3517
	July	0.1497	0.1640	0.2528	0.2959	0.3714
	August	0.1277	0.1662	0.2167	0.2586	0.2801
	September	0.1331	0.1694	0.2268	0.272	0.3388
	October	0.1413	0.1881	0.2460	0.3244	0.4166
	Average	**0.1379**	**0.1719**	**0.2356**	**0.2877**	**0.3517**
	Effect			**Pr > F**		
	Seed	0.0244	0.5712	0.1755	0.0851	0.3722
	Month	0.2465	0.3672	0.4294	0.5076	0.1696
	Seed*Month	0.127	0.2974	0.5541	0.6442	0.4918

When soil moisture was measured in the spring, we observed that there was no difference within soil depth due to seeding rates or seeding dates except in the top 0-6" between seeding rates. The 300,000 had the greatest available soil moisture while the 500,000 seeding rate had the lowest. It is not entirely clear why this was the observed trend as I hypothesized that soil moisture would decrease with increasing seeding rate. When total soil profile moisture content was analyzed, there was no difference in soil moisture due to seeding rate or planting month.

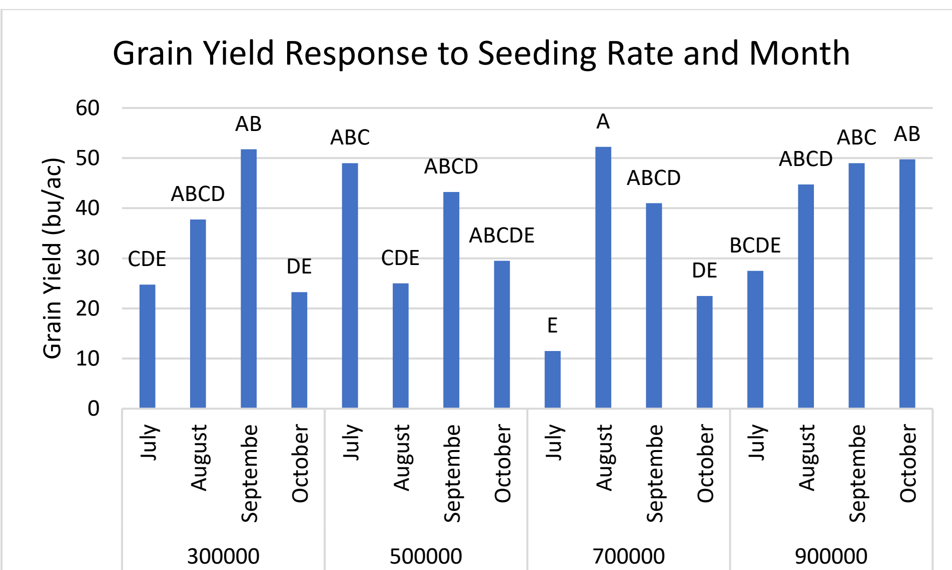

Chart 1 UI Sparrow grain yield response to pure live seeding rate and seeding month (third week of the month). Treatment means with the same uppercase letters are not significantly different at $p<0.05$)

For grain yield, there was a significant planting date by seeding rate interaction (P=0.0457). At the 300K and 700K seeding rates, August and September produced the greatest yields. The 900K seeding rate yielded better when grain was planted from August through October. At all seeding rates except 500K, seeding in July resulted in poorer yields than when seeded in one of the other months. Despite some differences in yields, there was no difference in test weights (58 lb/bu on average) between any of the treatments. This first year of results indicates that delaying planting of dryland winter wheat until mid-August or later may be a better management practice. If a grower waits to plant until October, seeding rates should be increased to obtain yields similar to earlier seeded fields.

2: Assess the relationship of available water and spring rainfall with dryland winter wheat grain yield

In 2022, we collaborated with 4 dryland winter wheat grain producers to collect soil samples and wheat yield estimates in eight fields in Roy, American Falls, Holbrook, Rockland, and Soda Springs. Soil samples were collected in the fall within 1 week of planting at the 0-6, 6-12, 12-24, 24-36, and 36-48" depths (or as deep as the soil profile allowed) from 3-5 georeferenced locations in each field (33 georeferenced data points). Each soil sample was analyzed for gravimetric water content, bulk density, and soil textural analysis. The post-harvest soil was composited across the soil sampling depths and analyzed for nitrate plus ammonium N.

Due to the harsh winter conditions, every single winter wheat field was terminated or overseeded with spring wheat by the producers. Of the 8 locations, 5 were replanted to spring wheat. Given the wet winter, we assumed that the soil profile was likely filled at the time of planting and did not collect spring soil samples to determine moisture content. To glean some potentially useful information from this study, we decided to proceed with the experiment and measure grain yield and post-harvest soil sample moisture content even though the crop no longer represented winter wheat.

In 2023, we collaborated with 4 dryland winter wheat grain producers to collect at-planting soil samples in 7 fields in Roy, Rockland, Holbrook, and Ririe. Soil samples were collected in the fall within 1 week of planting at the 0-6, 6-12, 12-24, 24-36, and 36-48" depths (or as deep as the soil profile allowed) from 3-5 georeferenced locations in each field (26 georeferenced data points). Each soil sample is being analyzed for gravimetric water content, bulk density, soil textural analysis, and N content.

For the 2022-2023 growing season fields, we estimated spring wheat yield by hand-harvesting a 5-foot by 5-foot section of grain from each georeferenced point (12 data points) by cutting the straw at the soil surface, separating the grain from the straw. We also collected field management information for each georeferenced point (e.g., seeding rate, variety, planting date, seeding depth, field aspect, slope, planting direction, residue cover, fertility rate, soil taxonomy, etc.). Daily precipitation will be recorded from the NOAA or AGRIMET weather station in the closest proximity to the field. Each collaborating producer was provided with a rain gauge to correct for deviations in daily precipitation, but the fields are remote and the growers were so busy that we were only able to periodically get precipitation corrections. However, some fields were located near a non-NOAA weather station that we could use for precipitation and weather data. The relationship between grain yield and available soil moisture plus precipitation will be calculated using linear regression.

Outreach / Applications / Adoption:

The seeding rate by planting date data generated from this study will be used to update the dryland wheat production guide. Additionally, this research will allow us to develop the relationship between dryland wheat grain yield with available soil moisture plus precipitation. This data may be combined with other datasets done in the Columbia Basin. This could be a valuable tool to help dryland wheat growers better estimate their potential yield for the coming growing season potentially saving money through improved input management.

Next Steps / Projections

Given the poor experimental results in the 2022-2023 growing season, we decided to not ask for additional funding to support the 2024-2025 growing season. We wanted to see how the 2023-2024 results look, and if they are promising, we will potentially renew the proposal for 2025-2026 growing season to add additional data points to the analysis.

Publications / Presentations / Popular Articles / News Releases / Variety Releases:

As this is the first year of this data from the UI collaboration, we have no publications to report.