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Agronomic Guidelines for Flexible Cropping Systems in Dryland Areas of Oregon

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Flexible cropping systems allow for an opportunistic change in an established rotation. The decision to grow a specific crop may be influenced by (1) commodity prices, (2) farm policy, (3) available cost-share programs, (4) pest pressure, (5) rotational benefits, and/or (6) plant-available soil water before planting. Plant-available soil water is the most reliable indicator of potential yield and is the basis of guidelines found in this publication.

Total Plant-Available Soil Water

Plant-available soil water is the quantity of water that can be extracted by the roots of plants. It is the water held in the soil between field capacity and the permanent wilting point. The total plant-available soil water content of silt loam and very fine sandy loam soils on the Columbia Plateau is approximately 2 inches per foot of soil. This level of water storage only occurs when soil is at field capacity.

Soil depth determines the total amount of water stored in a field. A 2-foot-deep Valby silt loam at field capacity will hold approximately 4 inches of plant-available water. The corresponding value for a 5-foot-deep Ritzville very fine sandy loam is more than 10 inches.

Field capacity occurs after soil is saturated and the downward movement of water is negligible. The **permanent wilting point** is the water content associated with severe water stress in plants. Water is unavailable. Plants will die if water is not added.

Left: Austrian winter peas. Right: Winter wheat. Photos by Larry K. Lutcher, Oregon State University.

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Effective Rooting Depth

The ability of a plant to extract water from soil is dependent on the effective rooting depth. The effective rooting depth is a function of management practices, soil properties, and the morphology of the plant's root system.

Shallow soils are typically 18 to 30 inches deep and are underlain by basalt or cemented hardpans. Condon and Valby silt loams are two good examples of shallow soil. Deeper soils such as Ritzville very fine sandy loam and Walla Walla silt loam are usually 5 or 6 feet deep. They contain less clay than many of the shallow soils and have a greater capacity to absorb and store overwinter precipitation.

It is important to note that the effective rooting depth may or may not be equal to the depth of the soil profile. Root growth can be severely impacted on soils that have a restrictive layer. Restrictive layers may be caused by tillage conducted while soil is wet; they also occur naturally in some soils and are the result of chemical and physical processes associated with long-term weathering. A soil probe can be used to "locate" the depth of a restrictive layer.

Some plants have an extensive root system. Others do not. The roots of cereals (wheat, barley, or oats) and *Brassica* species (canola, mustard, or camelina) can grow to a depth of 5 feet or more in the absence of a restrictive layer. Roots of peas and lentils grow to a depth of 2 or 3 feet.

Sampling, Testing, & Interpretation

Soil sampling should be conducted one or two weeks before fall or spring planting. Collect soil samples that are representative of the field from each foot of the effective rooting depth and place them in a bag or container that can be tightly sealed to avoid losses caused by evaporation. Store samples in a cooler or other similar container and send them to a soil testing laboratory as soon as possible.

Soil testing laboratories use an oven-drying method and estimates of the water content at both field capacity and the permanent wilting point to determine plant-available soil water. Results are reported as "available moisture" or inches of "plant-available water." It is possible to receive a report that shows 4 or more inches of plant-available water in the surface foot. These high values are the result of water content above field capacity—a situation that may occur early in the spring or after abundant precipitation. Growers and consultants should use caution when interpreting plant-available soil water content values greater than 2 inches per foot of soil. Gravitational flow will move excess water below the root zone if all layers of the soil profile are above field capacity.

Recommendations

Minimum plant-available soil water content values recommended for fall or spring planting are listed in table 1. Tabulated values have been adjusted for average, annual precipitation and are based on research findings and years of practical, on-farm experience.

Table 1. Minimum plant-available soil water content needed for fall and spring planting.

Average annual precipitation (inches)	Minimum plant-available soil water content (inches)*	
	Fall planting	Spring planting
<10	3.5	4.5
10 to 12	3.0	4.0
12 to 14	2.5	3.5
14 to 16	2.0	3.0
16 to 18	1.5	2.5
>18	1.0	2.0

Note: Values listed in this table are guidelines only.
*Effective rooting depth. Decisions to plant may be based solely on the anticipated quantity and timing of precipitation later in the growing season.

Flexible Cropping System Options

Flexible cropping system options are listed for an effective rooting depth that is either less than or equal to 30 inches (table 2) or greater than 30 inches (table 3). Listed options are dependent on average annual precipitation. Decisions to plant one crop or another should be made after review of plant-available soil water content values found in table 1.

Frequently Encountered Field Situations

The following four examples demonstrate the application of agronomic guidelines for flexible cropping systems in dryland areas of Oregon. Decisions to plant a particular crop, either in the fall or spring, may be open to interpretation or dependent on factors not covered in this publication—points emphasized in examples 5 and 6.

Alternative Method for Evaluating the Feasibility of Spring Planting

Spring planting decisions may be based on the wetting front. The wetting front is the position or depth of moisture in the soil profile. The depth of the wetting front can be determined with a soil probe or shovel and is usually evaluated in February or March. The potential for spring planting improves as the depth of the wetting front increases. There are no "hard-and-fast" rules associated with this technique. It is subjective and open to interpretation. Growers or agronomists who work in dry areas may decide to spring crop only when the wetting front is close to the bottom of the soil profile. Individuals who work in wetter areas may elect to take a less conservative approach.

The reliability of this method is dependent on a person's ability to determine field capacity using the "feel" method. It works reasonably well if all soil above the wetting front is at or near field capacity.

The wetting front method **should not be used to make fall planting decisions**, because soil above the wetting front is never anywhere near field capacity.

Table 2. Flexible cropping system options for an effective rooting depth less than or equal to 30 inches.

	Average annual precipitation (inches)					
	<10	10 to 12	12 to 14	14 to 16	16 to 18	>18
Flexible cropping system options	Fallow	Fallow	Fallow	Fallow	Winter cereals	Winter cereals
	Winter cereals	Winter cereals	Winter cereals	Winter cereals	Spring cereals	Spring cereals
	Spring cereals	Spring cereals	Spring cereals	Spring cereals	Legumes	Legumes
					Brassica spp.	*Brassica* spp.

Table 3. Flexible cropping system options for an effective rooting depth greater than 30 inches.

	Average annual precipitation (inches)					
	<10	10 to 12	12 to 14	14 to 16	16 to 18	>18
Flexible cropping system options	Fallow	Fallow	Fallow	Fallow	Fallow	Winter cereals
	Winter cereals	Winter cereals	Winter cereals	Winter cereals	Winter cereals	Spring cereals
	Spring cereals	Spring cereals	Spring cereals	Spring cereals	Spring cereals	Legumes
					Legumes	*Brassica* spp.
					Brassica spp.	

Example 1. Planting spring barley after winter wheat.

Available information
Soil type: Valby silt loam
Soil depth: 24 inches
Average annual precipitation: 13 inches

Soil test results for samples collected in February show a plant-available soil water content of 3.7 inches.
1st foot = 1.7 inches
2nd foot = 2.0 inches
Total = 3.7 inches

Planting feasible?
☑ Yes ☐ No

Comments
The plant available soil water content is 0.2 inches more than the recommended minimum (table 1). Spring cereals are listed as an option for an effective rooting depth less than or equal to 30 inches (table 2).

Example 2. Planting spring barley after winter wheat.

Available information
Soil type: Ritzville very fine sandy loam
Soil depth: 48 inches
Average annual precipitation: 10 inches

Soil test results for samples collected in February show a plant-available soil water content of 3.7 inches.
1st foot = 2.0 inches
2nd foot = 1.0 inches
3rd foot = 0.4 inches
4th foot = 0.3 inches
Total = 3.7 inches

Planting feasible?
☐ Yes ☑ No

Comments
The plant available soil water content is 0.3 inches less than the recommended minimum (table 1). Fallow is a better option when the effective rooting depth is greater than 30 inches (table 3).

Example 3. Planting spring peas after winter wheat.

Available information
Soil type: Walla Walla silt loam
Soil depth: 48 inches
Average annual precipitation: 17 inches
Effective rooting depth of peas: 2 feet

Soil test results for samples collected in April show a plant-available soil water content of 4.5 inches.
1st foot = 2.1 inches
2nd foot = 1.4 inches
3rd foot = 0.6 inches
4th foot = 0.4 inches
Total = 4.5 inches

Planting feasible?
☑ Yes ☐ No

Comments
The plant-available soil water content in the upper 2 feet of the soil profile is 1 inch more than the recommended minimum (table 1). Legumes are listed as an option for an effective rooting depth less than or equal to 30 inches (table 2).

Example 4. Planting spring peas after winter wheat.

Available information
Soil type: Walla Walla silt loam
Soil depth: 48 inches
Average annual precipitation: 17 inches
Effective rooting depth of peas: 2 feet

Soil test results for samples collected in April show a plant-available soil water content of 4.5 inches.
1st foot = 1.1 inches
2nd foot = 0.9 inches
3rd foot = 1.7 inches
4th foot = 0.8 inches
Total = 4.5 inches

Planting feasible?
☐ Yes ☑ No

Comments
The plant available soil water content in the upper 2 feet of the soil profile is 0.5 inches less than the recommended minimum (table 1). Fallow or planting spring cereal or brassica are a better option than spring peas in this situation. Cereals or brassicas will use water in the 3rd and 4th foot of this soil. Fallow will reserve the deeper water for the next crop.

Example 5. Planting spring oats after winter barley.

Available information
Soil type: Condon silt loam
Soil depth: 36 inches
Average annual precipitation: 14 inches

Soil test results for samples collected in March show a plant-available soil water content of 3.2 inches.
1st foot = 1.8 inches
2nd foot = 1.1 inches
3nd foot = 0.3 inches
Total = 3.2 inches

Planting feasible?
☑ Yes ☑ No

Comments
Annual precipitation of 14 inches is the transition of two ranges in table 1. Plant-available water content is either more or less than recommend depending on which line used. The decision to plant spring oats after winter barley, a potential option when the effective rooting depth is greater than 30 inches (table 3), is *open to interpretation* and should be based on field experience and management objectives.

Example 6. Planting winter canola after spring wheat.

Available information
Soil type: Athena silt loam
Soil depth: 48 inches
Average annual precipitation: 21 inches
Previous spring wheat crop suffered from "take-all" disease; this soil-borne, fungal pathogen affects root growth and reduces water uptake.

Soil test results for samples collected in mid-August show a plant-available soil water content of 3.1 inches.
1st foot = 0.1 inches
2nd foot = 0.4 inches
3rd foot = 0.9 inches
4th foot = 1.7 inches
Total = 3.1 inches

Planting feasible?
☐ Yes ☑ No

Comments
The plant-available soil water content is 1.1 inches greater than the recommend minimum (table 1). Winter canola is listed as a potential option in table 3. However, plant-available water in the surface foot is too low to provide adequate germination and emergence within the seed zone. Planting is not recommended for this situation, unless a wetting rain provides sufficient seedzone water to allow planting by September 20 followed by germination and emergence within 7 days.

Note: Guidelines in this publication should not be used to establish policy or program rules.

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