

Oregon State University Industrial Hemp Pilot Project, 2016-2020

Project Summary

Industrial hemp (*Cannabis sativa* L.) is a feed and fiber crop with an extensive history of worldwide cultivation. Over the past ten years, demand for hemp products has increased six-fold. However, as there are no current large-scale producers of industrial hemp in the US, a substantial import of hemp feed stocks from Canada and China is required. With the passage of Oregon senate bill 676 in 2009, many Oregon farmers expressed an interest in producing industrial hemp. However, grower adoption was and continues to be precluded by significant agronomic knowledge gaps, as no relevant production information or technical support is available for the Pacific Northwest or Oregon production zones. The Agricultural Act of 2014 provides language enabling higher education institutions to conduct research on industrial hemp, therefore providing Oregon State University an opportunity to provide regional specific agronomic information for Oregon growers. The goal of this project is to evaluate the feasibility of industrial hemp produced for fiber, grain and or cannabinoids (CBD, CBG) in field growing zones of Oregon. The Oregon State University Industrial Hemp Pilot Project is of five years duration and conducted mainly on the lands of the Oregon Agricultural Experiment Station, Oregon State University.

Project Contact

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Primary Objectives:

- 1. Evaluate industrial hemp varieties to identify lines that may be suitable for Oregon growers**
- 2. Identify and develop relevant agronomic recommendations for industrial hemp production across a range of growing conditions in Oregon**
- 3. Provide timely information to stakeholders and facilitate communication through various outreach activities**

Project Description

The scope of this project is to test the performance of industrial hemp varieties that may be adapted to the various production zones in Oregon and, depending on project findings, facilitate their adoption by Oregon growers. All varieties used in these trials will be from commercial sources to ensure that seed and varieties tested are the same varieties and seeds that are available to growers. In all trials, all varieties will be analyzed for THC content by the Oregon Department of Agriculture.

Objective 1: Evaluate industrial hemp varieties to identify lines that may be suitable for Oregon growers

Objective 1a Evaluate differences in growth and yield responses of select hemp varieties produced for production of fiber, grain and cannabinoids in order to identify lines that may be suitable for Oregon growers

The major goal of this project is to accurately identify industrial hemp varieties that can provide commercial gains in both on-average and across a set of target environments. As planting date and variety selection can have a profound effect on the development and yield of a crop, initial variety trials will also include evaluation of an optimum planting date to realize the full potential of a variety. Throughout the project we will use field plots (generally under five acres) on lands belonging to Oregon State University (OSU). During first two years only OSU lands will be used. During third and later years, grower fields would be considered for use in small-plot (under 5 acres) experiments, though the crop would be owned by and under the management of OSU.

Year 1-5

To maximize the value of crop yield data gathered by this project, detailed soil and climatic data will be taken at all study sites. Information regarding the chemical and physical properties of the soil throughout the soil profile at all study sites to a depth of 100 cm will be gathered: including starting and ending volumetric soil water content, soil bulk density, wilting point, field capacity, organic matter percentage, nitrogen, phosphorus, potassium and micronutrient content, pH, cation exchange capacity, and soil particle size analysis.

Prior to establishing plots, soil fertility levels will be standardized across the sites based on soil sample analysis. These studies will be arranged as a randomized complete block with four replications under conventional tillage, with the main-plots consisting of three planting dates with sub-plots being the twelve varieties. Sites will be monitored for precipitation, soil moisture and soil nitrogen levels in each plot. Soil moisture sampling probes and data loggers will be used to characterize soil water content within the soil profile. Weather stations will be established at each of the experimental plots. These weather stations will provide continuous measurements of soil temperature, air temperature, relative humidity and cumulative precipitation.

Phenological and growth parameters will be measured for each variety (See Essential Information). Phenological measurements will include dates of: emergence, flowering (start/duration) maturity, and yield. Growth parameters will include: above ground biomass, seed production (number and mass). For industrial hemp varieties that are harvested for seed, germination tests will be conducted to compare rate and total percent germination of the seed that was produced under different environmental conditions. Grain will be evaluated for quantity and quality of oils and fatty acids. Data

will be analyzed using MANOVA (phenology data) and ANOVA (growth measurements). Growing degree day models will be constructed for each varietal usage at each site.

Year 1. Replicated variety trials using twelve varieties will be conducted at Hyslop Crop Science Field Research Laboratory to identify the best hemp varieties, response to planting dates, and feasibility to produce industrial hemp under non-irrigated situations. Two field locations at Hyslop will be used with irrigation assigned to one field and no irrigation to the second, within each field, plating date will be assigned to whole plots using a randomized complete block design (RCBD) with variety assigned to subplots. All variety plots will be 3 m X 8 m with each variety replicated four times. Irrigation will be applied to all of the irrigated plots as needed. Plots will be planted with a seed drill with 20 cm or 40 cm row spacing with a target rate of 250-300 plants/m² for fiber and dual-purpose trials and 100-125 plants/m² for grain-only and cannabinoid trials.

Year 2-5. To obtain accurate and reliable predictions regarding yield potential of industrial hemp varieties in the diverse growing zones of Oregon, this project will engage CSS faculty at various research stations across the state in the second, third, fourth, and fifth years. Research plots on grower fields may also be considered in third, fourth and fifth years. Experimental design will remain as RCBD, however, previously tested varieties from year one may be excluded or additional varieties may be added to the study as data is collected on hemp variety potential in Oregon to determine the following:

1. The optimal varieties of industrial hemp in Oregon, with the goal of identifying varieties that perform the best at individual sites as well as any with better performance at multiple locations with different growing season conditions
2. The average yield of each variety at each site and averaged across sites.

Essential information collected, reported and used for analysis for the trial such as location, plot size, and trial management practices. Essential information will also include the results of soil analyses and meteorological data which adds value to the information on performance of varieties in the trials by helping to identify patterns among experimental sites and growing zones.

Essential Information:

1. Location of Trial
 - a. Town/City name
 - b. Latitude, Longitude and Altitude
2. Planting and Dates (including crop duration)
 - a. Soil test data
 - i. Fertility and Physical properties
 - ii. Herbicide history of field location
 - iii. Prior cropping history
 - b. Seedbed preparation methods
 - c. Planting methods

- i. Row spacing
 - ii. Seeding rate
 - iii. Planting depth
 - iv. Assessment of effectiveness of seed coverage/placement
- 3. Plot Description
- 4. Plot Size
- 5. Crop rotation
- 6. Soil Description
- 7. Meteorological data during the trial
- 8. Seed Stock
 - a. List of varieties
 - i. Intended use (fiber, seed, CBD, dual purpose)
 - ii. Country of origin
 - b. Seed quality
 - c. Seeds per pound Seed
- 9. Plant phenology
 - a. First emergence date
 - b. Date to 90% emergence
 - c. Seedling mortality
 - d. Estimation of plant growth stage observed and recorded at least twice a week
 - i. Height, branching, number of nodes and plant architecture
 - e. Date of first bud, first flower, peak flowering, and end of flowering time
 - f. Date of first release of pollen, peak pollination and end of pollination
 - g. Seed stages
 - i. Maturity and moisture content
- 10. Crop yield
 - a. Harvest dates
 - i. Timing
 - ii. Equipment
 - b. Stalk yields
 - i. Biomass per unit area
 - c. Grain yield per unit area
 - d. Bud/floral yield
 - i. Cannabinoid (e.g., CBD) quality
 - ii. Cannabinoid (e.g., CBD) volume

Objective 1b Quantify interactions between agronomic practices and factors such as water stress, temperature, nutrient deficiencies, harvest methods and other factors on yield and quality of various components

Year 4-5 Based on the results of the reciprocal variety studies in Years 1, 2, and 3 additional studies will be established with the most suitable varieties following similar protocols for Year 1. These experiments will be designed to explore the impacts of irrigation timing, harvest methods, row-spacing in no-till and conventional till, weed

suppression and soil fertility on yield and quality of fibers, seed and cannabinoids. In addition, as there are no current labeled pesticides for hemp, pesticide screening trials will be conducted as well.

Objective 2: Identify and develop relevant agronomic recommendations for industrial hemp production across a range of growing conditions in Oregon

By year 3 and during subsequent years it is anticipated that the information derived by completing objective 1a and 1b will begin to inform industrial hemp cropping system design and management decisions in these systems within the various growing zones of Oregon. Specifically, management recommendations including variety selection for desired end components and their expected yields, minimum irrigation requirements, pest species that are favored in these cropping systems and pesticide rates needed for adequate control. This project will offer an opportunity to identify and label pesticides for use in Industrial hemp in Oregon.

Objective 3: Provide timely information to stakeholders and facilitate communication through various outreach activities

Over the timeline of this project, realistic assessments of the potential of industrial hemp cultivars in Oregon, relevant data and recommendations pertinent to various stakeholders will be disseminated through:

1. Publication of project results in scientific journals and other outlets.
2. Development of extension bulletins targeted to growers in each growing region.
3. Multiple formal and informal presentations, demonstrations, and field days targeted to growers in each growing region
4. Creation of a project website to provide web-based information to improve access to research results and variety profiles.

Activity 1. Create a project website compiling the data from Objectives 1a and 1b and include the recommendations created in objective 2. The website will include the results of the variety trials and provide relevant production methods collected from the project. The most likely audience for this information will be industrial hemp growers in the PNW.

Activity 2. Produce an extension publication on the biology and agronomic production of industrial hemp in Oregon. This publication will identify suitable hemp varieties and best management practices from the results of the experiments conducted in Objective 1a and 1b. This publication will include agronomic production practices if industrial hemp is produced for CBD production.

Activity 3. Deliver the information from this project to growers through tradition outlets such as field days and extension meetings and publications.

Five-year project timetable

Spring 2016 - Importation of hemp seed; Establishment of experimental fields in Benton County.

Summer 2016 - visits to industrial hemp research field trials in Kentucky, Colorado and North Dakota. (see comparative table, appended in this document, for how other states are treating Industrial Hemp)

Fall 2016

First harvest; creation of project website; Evaluation of initial variety trial data.

Spring 2017

Establishment of additional variety trials at new OSU sites.

Fall 2017

Second harvest; Evaluation of variety studies; provide data to website; development of management recommendations and materials and design of treatments at field locations.

Spring 2018

Initialization of field herbicide screenings; continuation with variety trials.

Fall 2018

Third harvest; Evaluation of experimental results from field sites; continued refinement of management recommendations.

Spring 2019

Initialization of irrigation, fertility and other management studies at the field location sites.

Fall 2019

Fourth harvest; publication of ongoing experimental results; provide recommendations at Extension and other outreach events.

Spring 2020

Continuation with variety trials and other studies at the field location sites; participate in various field day and outreach events.

Fall 2020

Fifth harvest; completion of variety trial studies; Publication of experimental results; provide recommendations at Extension and other outreach events.

Timeline of Research Activities

	<u>2016</u>	<u>2017</u>	<u>2018</u>	<u>2019</u>	<u>2020</u>
<i>Hemp Seed Collection</i>	X	X			
<i>Objective 1a</i>	X	X	X	X	X
<i>Objective 1b</i>				X	X
<i>Objective 2</i>				X	X
<i>Objective 3</i>	X	X	X	X	X
<i>Publication of Results</i>				X	X

As with any field-based agricultural studies there is always the potential for unforeseen environmental factors such as drought or disease and insect infestations in addition to management errors that can occur which will limit the utility of a particular experimental site in a particular year.

OSU Industrial Hemp Pilot Project Draft Budget

This is a five-year project. Duration of five years is required for research-grade agronomic study. Any support less than budgeted below shortchanges outcomes of desired robust scientific results, and thus the project would not be worth funding.

Year 1 - 2016

Personnel

1	Research Associate (Post-doc) (salary, benefits)	\$72,000
1	Graduate Research Assistant (salary, benefits, tuition)	\$55,000
	Supplies	\$32,000
	Lab tests	\$4,000
	Travel	\$10,000
	Farm field prep, rental and fees	\$8,000
	Equipment	
1	Plot combine and trailer	\$230,000
1	Plot planter	\$150,000
1	Field air-soil weather station	\$15,000
		\$576,000

Years 2-3 - 2017-2018

Personnel

1	Research Associate (Post-doc) (salary, benefits)	\$146,000
2	Graduate Research Assistants (salary, benefits, tuition)	\$224,000
	Supplies	\$30,000
	Lab tests	\$9,000
	Travel	\$24,000
	Farm field prep, rental and fees	\$33,500
	Equipment	
1	Post-harvest processor	\$80,000
		\$546,500

Years 4-5 - 2019-2020

Personnel

1	Research Associate (Post-doc) (salary, benefits)	\$149,000
2	Graduate Research Assistants (salary, benefits, tuition)	\$230,000
	Supplies	\$24,000
	Lab tests	\$12,000
	Travel	\$24,000
	Farm field prep, rental and fees	\$35,000
	Equipment	\$-
		\$474,000
		\$1,596,500