Agronomic Considerations for Industrial Hemp Production

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Note: At the time of publication, OSU researchers and Extension specialists have not evaluated agronomic production practices for hemp in Oklahoma. All information presented in this fact sheet is based on work conducted at other Land Grant institutions.

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What is Industrial Hemp

Industrial hemp (*Cannabis sativa* L.) is unrelated to sunn hemp, waterhemp, hemp sesbania or hemp dogbane, but is the same family and species as marijuana. The primary difference between hemp and marijuana is the concentration of delta-9-tetrahydrocannabinol (Δ^9 THC). By law, industrial hemp must have no more than 0.3 percent Δ^9 THC on a dry weight basis. This is true for all parts of the plant, including seed, regardless if the plant is growing or not.

Hemp is historically dioecious, meaning plants will be either male or female. Depending on end use, it may be critical to know if male plants are desirable or detrimental. For fiber production, males are more desirable because they often can produce more biomass and senesce (die, drop leaves) earlier. In grain production, a small percentage of male plants are needed to pollinate female plants so they can set seed. Male plants are undesirable for floral production because they contain less cannabidiol (CBD) content, and if female plants are fertilized with pollen, their CBD content can be limited. If the concentration is too low, it may become an unmarketable crop.

The Products of Hemp Production

Industrial hemp has multiple end uses. Knowing the final use of the product is critical, as it will dictate variety selection and management.

Fiber – Hemp fiber can be used for clothing, fiber board, paper and building material. Typically, hemp produced for fiber will be harvested 60 to 90 days after planting.

Grain/Hempseed Oil – Hemp grain can be used for human consumption. Many sources state that hemp seed protein can be used in the same manner as soybean seed protein. These proteins can be used to create tofu, veggie burgers, butter, cheese, milk, ice cream and oils. The oil can be used for personal care such as soaps. To produce hemp seed, it typically takes 110 to 150 days.

Floral / CBD – The floral components of hemp can be harvested for their oils. The oils produced by the floral components differ from the grain as they are high in CBD oil. These oils are commonly sold for reported medicinal properties. The CBD oil currently has the greatest profit potential of all industrial hemp products.

Dual Purpose – This production system harvests the grain and fiber or floral bud and fiber. The total amount of CBD production can yield more per acre when leaf material and floral buds are utilized, but CBD concentration from the combined biomass is significantly lower than hemp grown only for floral production. The extractor will yield less CBD per ton of the combined biomass, which could lead to a lower price or become unmarketable. Due to management differences and delayed harvest, fiber production of the dual purpose crop also is typically less than that of a fiber only crop.

Varietal selection

All hemp seed planted must be on the Certified Low THC Variety List, which is produced by the Oklahoma Department of Agriculture, Food and Forestry (ODAFF). **This is not the same as *Certified Seed* as designated by the Oklahoma Crop Improvement Association.** Certified Low THC seed has been documented to produce plants with no more than 0.3 percent. Additionally, the seed must be obtained from a source listed on the ODAFF approved list. Most hemp seed will have a test weight of 42 to 44 pounds per bushel and approximately 15,000 to 27,000 seeds per pound.

The planned end use is also very important when considering variety selection. Like in other crops, there is significant variety variation in height, biomass production, fiber quality, grain production and quality, as well as CBD production and quality. Typically, crop height is associated with end use, taller varieties are used for fiber and medium and semi-dwarfs are used for their reproductive structures (i.e. floral and seed). Taller varieties are typically 7 to 18 feet tall, medium are 6 to 7 feet, semi-dwarfs are 4 to 5 and dwarf varieties are 3 to 4 feet. Identifying the production goal is critical in choosing the proper variety. It is important to note that Oklahoma State University has not conducted industrial hemp variety trials and does not have a recommended list of varieties.

Field Selection

Most publications suggest hemp should be grown in well drained soils with a neutral soil pH (6 to 7.5). The deeper the soil, the deeper the plant roots can explore and search for water during Oklahoma hot summers. Due to the lack of registered herbicides, fields should be selected that have minimal weed pressure.

Field Prep and Planting

Planting should occur after soil temps are above 46 to 50 F, in a firm, level, weed-free seed bed. Hemp is strongly photosensitive, meaning it flowers according to day length. The reproduction

growth stage will initiate once day length nears 12 hours, which is typically late September. The expected planting date should also take into account when the crop might mature and the peak summer heat. Like many summer crops, a viable strategy for avoiding summer heat is to plant early to mature prior to the onset of heat or plant later to mature after temperatures moderate in early fall. Each option for heat avoidance presents its own challenge. Early planting dates present challenges due to cool soil temperatures and frequent soil temperature fluctuation along with late spring freezes. Adequate soil moisture at planting and enough time finish the crop prior to the first freeze are challenges with later planting dates.

Fiber – When growing industrial hemp for fiber production, the goal is to produce a tall plant with narrow stems. To achieve this, it is best to plant in narrow rows and at a high population, with a target of 15 to 35 plants per square foot. Assuming there are 20,000 seeds per pound, the target seeding rate will range between 33 to 76 pounds of seed per acre, depending on planting conditions and seed quality. Growers need to acquire or determine germination percentage prior to planting and adjust seeding rates accordingly.

Grain/Hempseed Oil – Moderate branching is desired for increased seed production. Therefore, the target population is 10 to 15 plants square foot and 22 to 33 pounds of seed per acre (assuming 20,000 seeds per pound). A grain drill is recommended for a quicker canopy coverage, which will reduce weed competition.

Floral / CBD – Wider rows and significantly lower populations are needed for floral bud (CBD) production. Whether planting seed or transplants, all plants should be female. The majority of hemp grown for CDB in field is planted on a 2- to 6-foot grid. Planting in a grid allows for both increased side branching and easier access for manual weed control and harvest.

Fertilizer

Little is known about the nutrient needs of industrial hemp produced in Oklahoma. Publications from other universities suggest 100 to 150 pounds per acre nitrogen, along with phosphorus and potassium based upon a soil test with rates similar to winter wheat (See Fact Sheet PSS-2225, *OSU Soil Test Interpretations*) and a total sulfur level of 10 to 15 pounds per acre. Some publications suggest soil test calcium levels of less than 6,000 parts per million.

IPM

Currently, there are no EPA registered insecticides, fungicides or herbicides labelled for use in industrial hemp. This means most pesticides that can be used on other crops cannot be used on industrial hemp. There are some Minimum Risk Pesticides, or 25(b) products that pose little or no risk to human health or the environment, and are exempt from registration by the Environmental Protection Agency (EPA). Although these products are exempt from registration by the EPA, they must be registered by the Oklahoma Department of Agriculture, Food and Forestry (ODAFF) to be legally used in the state. Any products that claim to be 25(b) must be on the Eligible Active Ingredient list. This information may be found in (40 CFR 152.25(f)(1)).

THC Levels

One of the greatest risks in producing industrial hemp is the regulation requiring hemp that tests Δ^9 THC level above 0.3 percent must be destroyed. Currently, it is challenging to predict when a crop might reach these levels. Most work suggest that when the crop is under stress, the probability of increased Δ^9 THC levels increases. Stress that could increase THC concentration may include, but not limited to drought, heat, excessive or deficient nitrogen, other nutrient deficiencies and disease and pest pressures. It has also been shown that there is a significant variety by environment component to high THC levels.

Current ODAFF regulations require an official test to be collected within 30 days of harvest. Growers can send samples to independent labs to self-monitor the crop to tract Δ^9 THC concentrations. It is not understood if, or by how much, levels could fluctuate in the plant throughout the season. If concentrations begin to rise, harvest of hemp for fiber may need to occur sooner than anticipated. More work is needed to better understand the impact of variety, environment and stress on THC levels.

Harvest

Fiber – The crop needs to be swathed during the period of early bloom to seed set for best quality. After swathing, plants need to go through retting, a process that breaks down bonds between fibers. The microbial process takes about one and a half to five weeks to break the bonds between the bast (long outer fibers) and the hurd (short inner core fibers). Occasionally, hemp also needs to be raked multiple times to remove leaves before it can be baled for transport.

Grain/Hempseed Oil – Hemp seed has a high risk of shattering, so it is recommended to harvest when 70 to 80 percent of the grain has matured. This will result in harvesting grain at a high moisture content of 15 to 30 percent. To prevent oil decay, the grain needs to be quickly dried to a target moisture content of 7 to 10 percent. Some documentation suggests that recommended combine settings for grain sorghum may be a good starting point for hemp.

Floral / CBD – The conventional method for harvesting hemp for CBD resembles that of burley tobacco harvest. The plant is cut at the base and then hung for curing. Curing is important to ensure the quality of product. Plants should be hung upside down in a well-ventilated barn or drying chamber. Sources suggest drying length can change due to varying temperature and humidity levels and plants should be monitored every three to seven days until thoroughly dried. After drying, the floral components are removed from the plants. This entire process is done by hand to protect the high value and delicate floral buds.

Dual Purpose – Mechanical harvest is timed for either floral or grain harvest. After harvest, the remaining stalks are retted, then baled in the same process as fiber production.

Machinery – All resources on hemp harvest share the same caution when machinery of any kind is used to harvest hemp. All industrial hemp has the same fibers stalks. As machinery goes through a field, there is a tendency for fiber to bind and wrap around any moving part. Many producers have found tricks to reduce this problem, such as putting PVC pipe around moving parts, but there is no fail-safe solution. Care must be taken during field operations and equipment should be checked regularly.

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