Agronomic Recommendations for Industrial Hemp Production in Kentucky-2016

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It is important to note that until 2015, there had been no U.S.-based agronomic research studies with industrial hemp (IH) since the early 20th century. Information from previous research is important and useful, but may not always be optimal for use in modern production systems. It is already very clear that different varieties of IH will respond differently to basic agronomic inputs. This is especially true regarding varieties grown for different purposes. Varieties grown for fiber-only will be established and managed differently than varieties grown for grain or dual-purpose. Fiber and/or grain varieties will likely be established and managed very differently than those grown for cannabinoids. The University of Kentucky and others conducted basic agronomic trials beginning in 2015 with varieties grown for all three harvestable components (fiber, grain, and cannabinoids). Information from hemp research efforts at UK including an overview of 2015 UK hemp research is available at: http://hemp.ca.uky.edu/. The scope of 2015 research efforts at UK were relatively limited by several factors, including late planting of some trials. The recommendations below represent the most appropriate information available today, but will certainly be adjusted to Kentucky climatic conditions and modern production systems as data from new research becomes available, including repeating the 2015 trials reported at the UK hemp website during the 2016 growing season.

Please consider the information below relative to the complete lack of refereed, science-based information from U.S. institutions, including Kentucky. Information on IH production in Kentucky will be available from the UK College of Agriculture Extension Service as it is produced. This is not an official UK publication. Rather, it is a narrative providing information to producers without the strong and useful benefits of replicated field research conducted in the U.S. and Kentucky.

Basic terms and definitions

Pure live seed (PLS): is the seed in a container that will likely produce a viable plant when planted appropriately (depth, timing, etc.). Recommended seeding rates are always expressed as pounds of PLS/A. All containers of seed will have a mass or weight of materials in addition to PLS. This is usually expressed as a percentage of the total weight in the container. Examples include inert materials (soil, chaff, and other plant parts) as well as seed that will likely not germinate (immature or dead seed). Other contributions to reductions of PLS in a container are other crop seeds and weed seeds. The percentages of inert or other materials (non-crop seed) along with the germination percentage of the crop seed defines PLS. For example, a container includes 5% non-crop seed and has a germination rate of 75%. This means that 5% of the weight of the material in the container is not crop seed and that only 75% of the crop seed will likely germinate and produce a new plant. In order to calculate the amount of seed needed to accommodate recommended seeding rates, we need to increase the amount seed planted by 30% above the recommended seeding rate (5%+25%; the sum of non-crop seed and crop seed that will likely not germinate). For example, if the recommended seeding rate is 60 pounds of PLS/A, we divide the seeding rate (60) by the PLS percentage (0.70 which equals 70%). The result is we would need to apply approximately 86 pounds of this particular seed per acre to achieve the 60#PLS/A seeding rate. It seems likely that seed labeling as we are accustomed to it in the U.S. may not always be immediately available for IH seed. At the very least, if germination percentages are not provided, it would be wise to have a germination test performed prior to seeding. This is true even if non-crop seed percentages are not available. We have witnessed very poor germination of some hemp varieties, and have received several anecdotal reports of the same. Poor germination equates to poor stand establishment. Poor establishment leads to increased weed pressure, reduced yields, and harvesting problems. Using the proper seeding rates based on PLS is imperative for successful hemp production and harvest.

Nitrogen: application rates are expressed as units or pounds of actual nitrogen (N) per acre. The amount to apply using a specific fertilizer is calculated by dividing the desired N application rate by the analysis of the fertilizer. For example, to apply 50 units of N/A using urea (46-0-0), we divide 50 by 0.46 (46% N in urea) which equals approximately 109 pounds of urea applied per acre.

Current Recommendations

Site selection and inputs

Although IH has been touted as a low-input crop highly adaptable to marginal lands, the scientific literature from other countries clearly indicates that maximum yields are realized with inputs equivalent to current grain production systems (e.g. wheat) and on productive land (170+ bu/A corn). If maximum IH yields are the goal, select good corn land and plan on inputs equal to current grain crops. If maximum yields are not the goal, IH can be expected to perform on lands with lower productivity and with reduced inputs much the same as our current commodity crops would.

Varietal responses

Variety selection will be key to success for many reasons. These include days to maturity (regional adaptation) and seed quality. There is much to know about selecting the proper variety; too much information to include here. For example, varieties bred primarily for grain production could have significantly different maturity dates relative to each other, and therefore would have very different establishment dates for maximum yields. Producers should research varieties based on the harvestable component of interest (fiber, grain/fiber, or cannabinoids) and choose varieties that are proven performers in other countries with acceptable germination rates. Work is underway to define and then implement standards for the production and sale of certified IH seed in the U.S. Until that time, we must rely on the standards of other countries, or in some cases, have no standard information from unbiased sources about the varieties that are available. Standard IH variety trials will begin at UK in 2016.

Establishment from seed

It appears that IH seed could be quite sensitive to soil moisture at planting. This trait has not been quantified but could readily contribute to stand failures. Seed should be planted in soils with adequate moisture to encourage rapid germination. If soil moisture is inadequate for IH germination, it is likely still adequate to support the germination of many weed seeds. Without the availability of legal herbicide applications in IH production systems, we rely heavily on rapid IH canopy development and closure to reduce or eliminate competition from weeds. Adequate soil temperature and moisture at planting will help accomplish this. Planting depth should never exceed one inch (1”), and 1/4-1/2” depths are preferred. It appears that IH seed can be successfully drilled with both conventional tillage and no-till protocols. Seeding dates will depend on the harvestable component and equally on variety. Fiber crops will be harvested at the onset of reproductive growth and should be planted as early as possible to maximize vegetative growth. Days to maturity of grain crops can vary a great deal among varieties. As such, some grain varieties should be planted much later than others. Field-scale cannabinoid production systems are not yet well-defined. Lacking appropriate research-based information, cannabinoid production from seed should be thought of similarly to grain production. In very general terms, IH seed should be planted in late April or early May in Kentucky. Seedling IH is tolerant of light frosts, but it is probably best to avoid the last killing frost while still taking advantage of good spring soil moisture and temperatures at planting.

Pesticides

There are currently no pesticides (herbicides, insecticides, fungicides, nematicides, etc.) labeled for use in IH crops in the U.S. This is true for both indoor and outdoor (field-scale) production systems. This means that any pesticide applications to IH crops are off-label and therefore illegal. The only exceptions would be applications made by university researchers. Work is underway to evaluate pesticides for use in IH production systems and also to investigate several options for exemptions within the rules and policies of the U.S. *FIFRA*. Today, it is imperative to make good management decisions to reduce the negative effects of pests, particularly weeds. Seeding dates, seeding rates, and fertility are examples of management decisions that will potentially reduce competition from weeds and increase yields without herbicides. To date, we have not witnessed significant pressure from insect or disease pests in field-scale production systems. There have been serious reports of both disease and insect pests in indoor growing systems.

Harvest protocols

Harvesting IH grain by combine is the norm in other countries and was accomplished successfully here in Kentucky in both 2014 and 2015. Again, variety selection is key as the growth habits of those varieties bred primarily for grain production are more conducive to harvest by combine. Varieties bred primarily for fiber production could be very difficult or perhaps impossible to harvest efficiently by combine. Harvesting fiber crops is much more complex. The equipment for optimal cutting and then management of the crop during retting does not yet exist in the U.S. Additionally, field-retting IH will require new skills remotely similar to those involved in making high quality hay. Not every producer has learned the skills necessary to produce the highest quality hay, and not every hay crop is highest quality. Successful field retting will be totally dependent on weather conditions just as is making good hay. Today, harvesting IH for fiber will be difficult at best. Current thinking involves mowing by sickle-bar, retting in the field, followed by baling (round or square). Another option is harvest by forage chopper, but this presents new issues such as efficient transportation and storage prior to processing. Harvesting methods for fiber crops will also depend heavily on the intended use of the fiber (e.g., yarns and fabric compared to industrial uses compared to animal bedding). Optimal harvest methods for cannabinoids are not well defined in field-scale systems. Research is underway at UK to address all of these questions.

General recommendations for the main harvestable components of industrial hemp.

	Fiber	Grain/dual purpose	Cannabinoids*
Seeding Rate (PLS)	60#/A	20-40#/A	20-40#/A
Row spacing	4-8 inches	8-16 inches	8-16 inches
Applied Nitrogen	50 units/A	150 units /A	50-100 units/A
Harvest	</=20% male flowering	~70% grain maturity	~75% trichome maturity

*Optimum agronomic protocols for cannabinoid production in field-scale systems have not been defined. Much of what we know is extrapolated from Cannabis production systems in U.S. states where it is legal and/or from other countries. Nearly all of these systems are indoor and not field-scale. Very important questions remain regarding field-scale systems to produce cannabinoids. These include variety selection, establishment methods (e.g., direct seeding versus transplanting), and management decisions including nitrogen fertility and harvesting. Research is underway to address these questions.