2019

Annual Hemp Regulatory Report

Office of
Indiana State Chemist & Seed Commissioner
175 S. University Street
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West Lafayette, Indiana 47907-2063

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Seed Administrator

2019 Annual Hemp Regulatory Report

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Indiana 2019 Annual Hemp Report

Presented here within is the 2019 Annual Hemp Report of the Office of Indiana State Seed Commissioner. It represents a summary of official inspectional activities related to hemp in Indiana, as well as laboratory analyses performed on official samples collected under the authority of Indiana Hemp Law for hemp grown in Indiana.

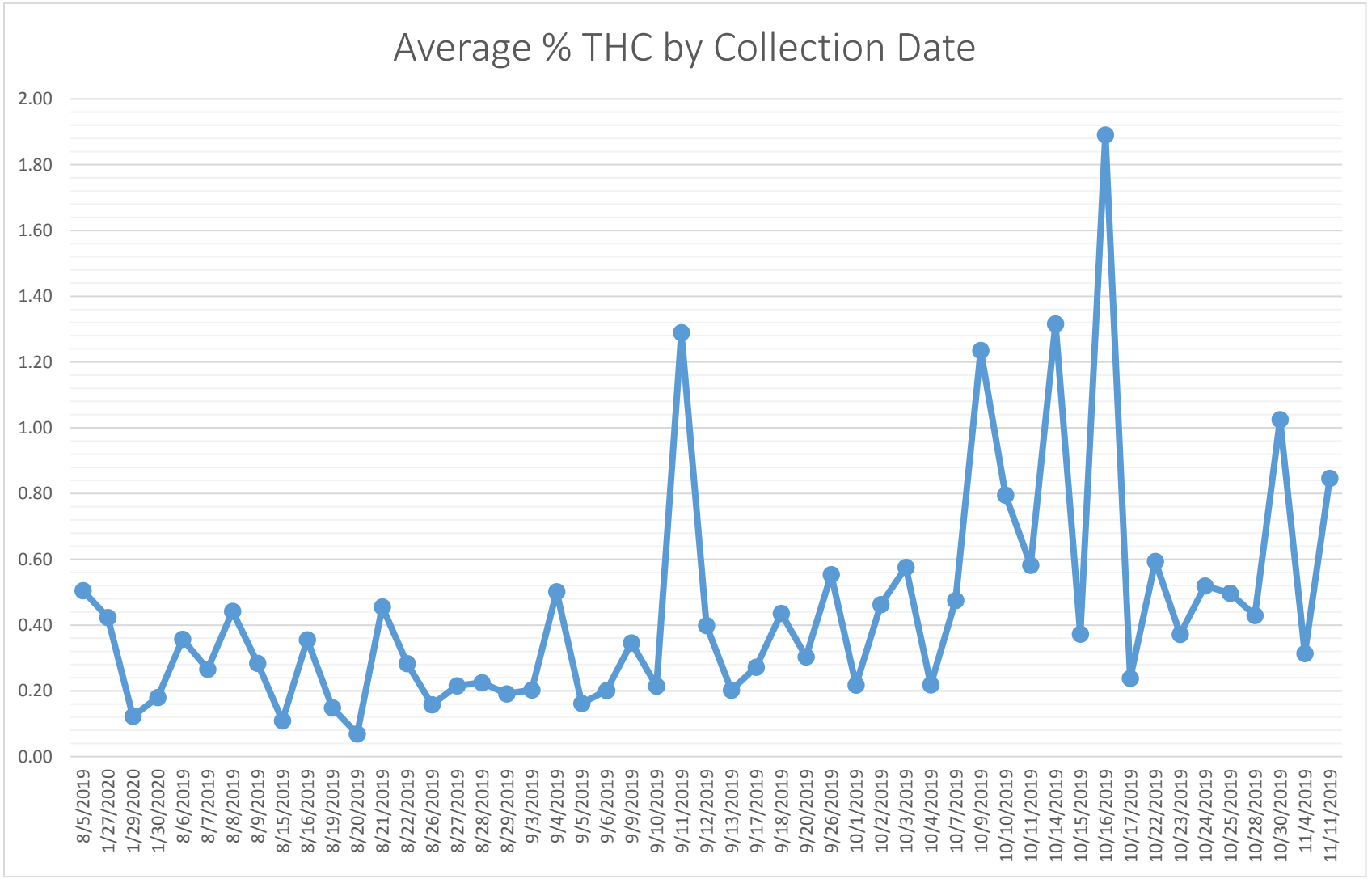
The Indiana Seed Law as it applies to hemp is a "truth-in-labeling" law requiring basic quality factors to be expressed to represent a level of quality to potential purchasers and consumers. The purpose of the law is to provide the consumers with adequate information, through fair and consistent labeling, to make intelligent purchases of agricultural and vegetable seed products. OISC has been in the lead nationally on requiring full labeling of hemp seed to protect the growers from dubious claims, weed seeds and low germination rates. For testing hemp seed, our office is a charter member of the Association of American Seed Control Officials (AASCO) and the Association of Official Seed Analysts (AOSA) and we abide by the rules and protocols established by those associations. With 49 hemp seed germination tests completed in the Indiana State Seed lab the results in 2019 averaged 51% germination

The inspection staff of the Indiana State Chemist and Seed Commissioner provides marketplace surveillance throughout the state through inspectional visits to hemp growers in Indiana. These growing areas consist of growth for CBD, fiber, grain, seed oil and seed as well as other uses. Samples are obtained through official sampling methods and are analyzed in the Indiana State Hemp Laboratory to determine compliance with legal THC limits.

This report accurately reflects the dedication to our statutory responsibilities to enforce the Indiana Hemp Law and provide this information to the public through this report.

Prepared and Submitted By:

Donald B Robison
Seed Administrator


Average % THC by Collection Date
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
8/5/2019
1/27/2020
1/29/2020
1/30/2020
8/6/2019
8/7/2019
8/8/2019
8/9/2019
8/15/2019
8/16/2019
8/19/2019
8/20/2019
8/21/2019
8/22/2019
8/26/2019
8/27/2019
8/28/2019
8/29/2019
9/3/2019
9/4/2019
9/5/2019
9/6/2019
9/9/2019
9/10/2019
9/11/2019
9/12/2019
9/13/2019
9/17/2019
9/18/2019
9/20/2019
9/26/2019
10/1/2019
10/2/2019
10/3/2019
10/4/2019
10/7/2019
10/9/2019
10/10/2019
10/11/2019
10/14/2019
10/15/2019
10/16/2019
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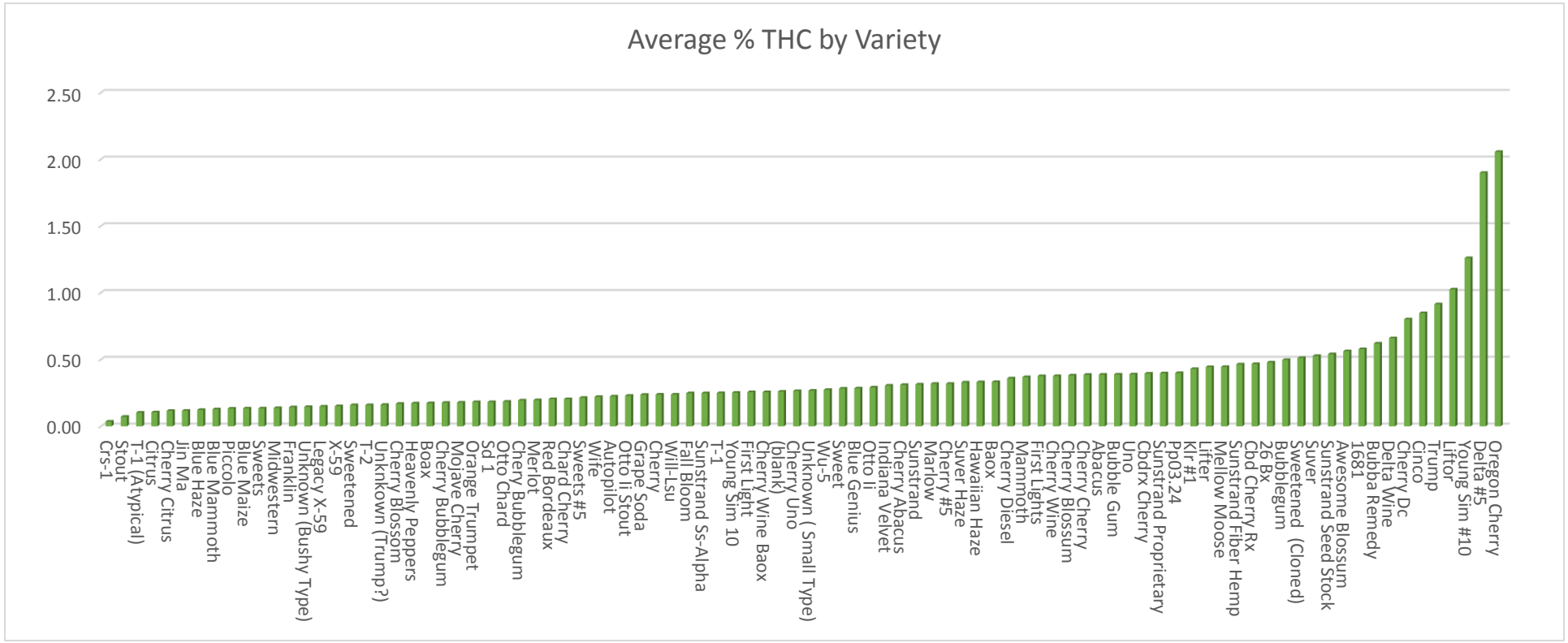
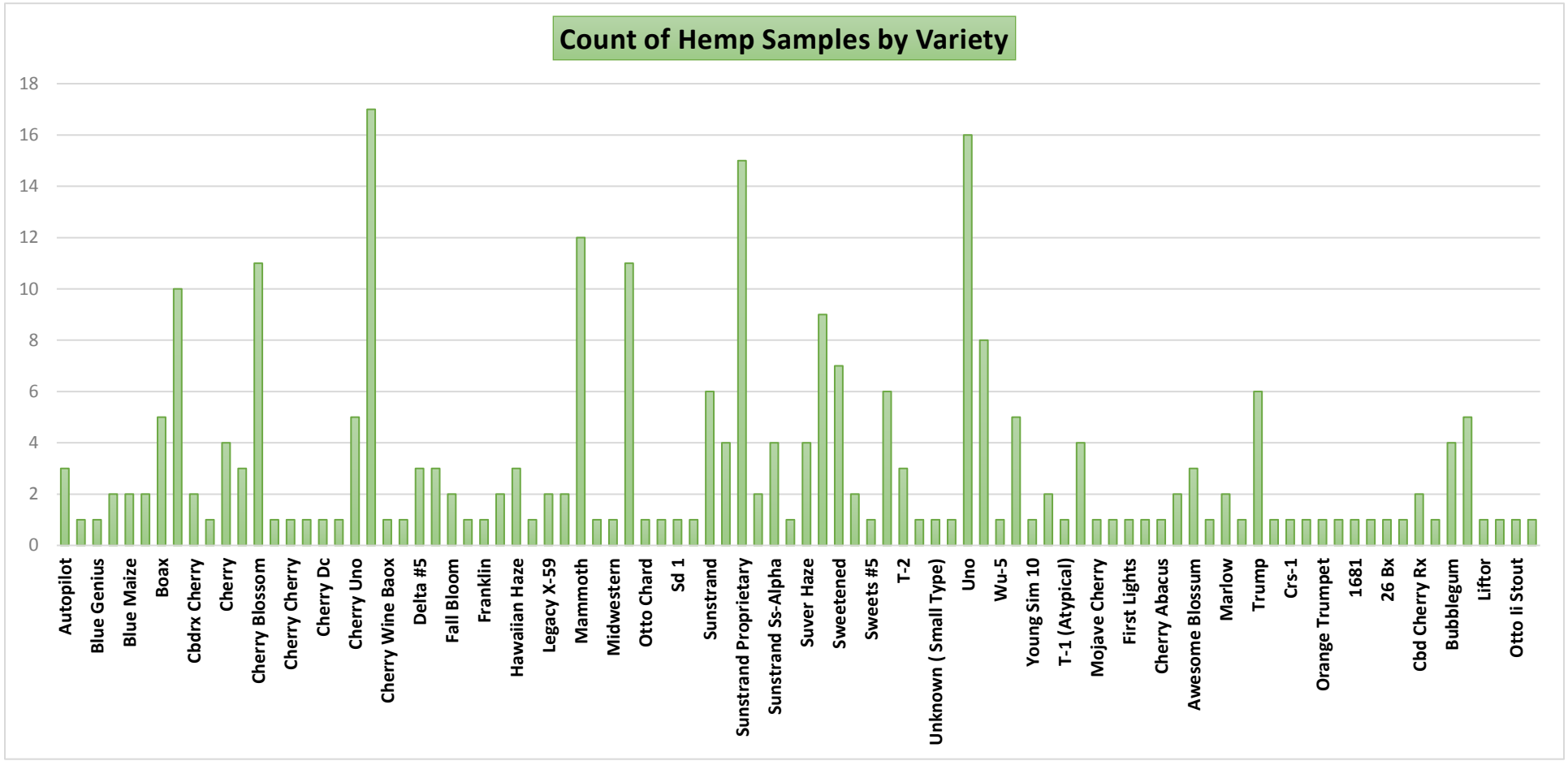
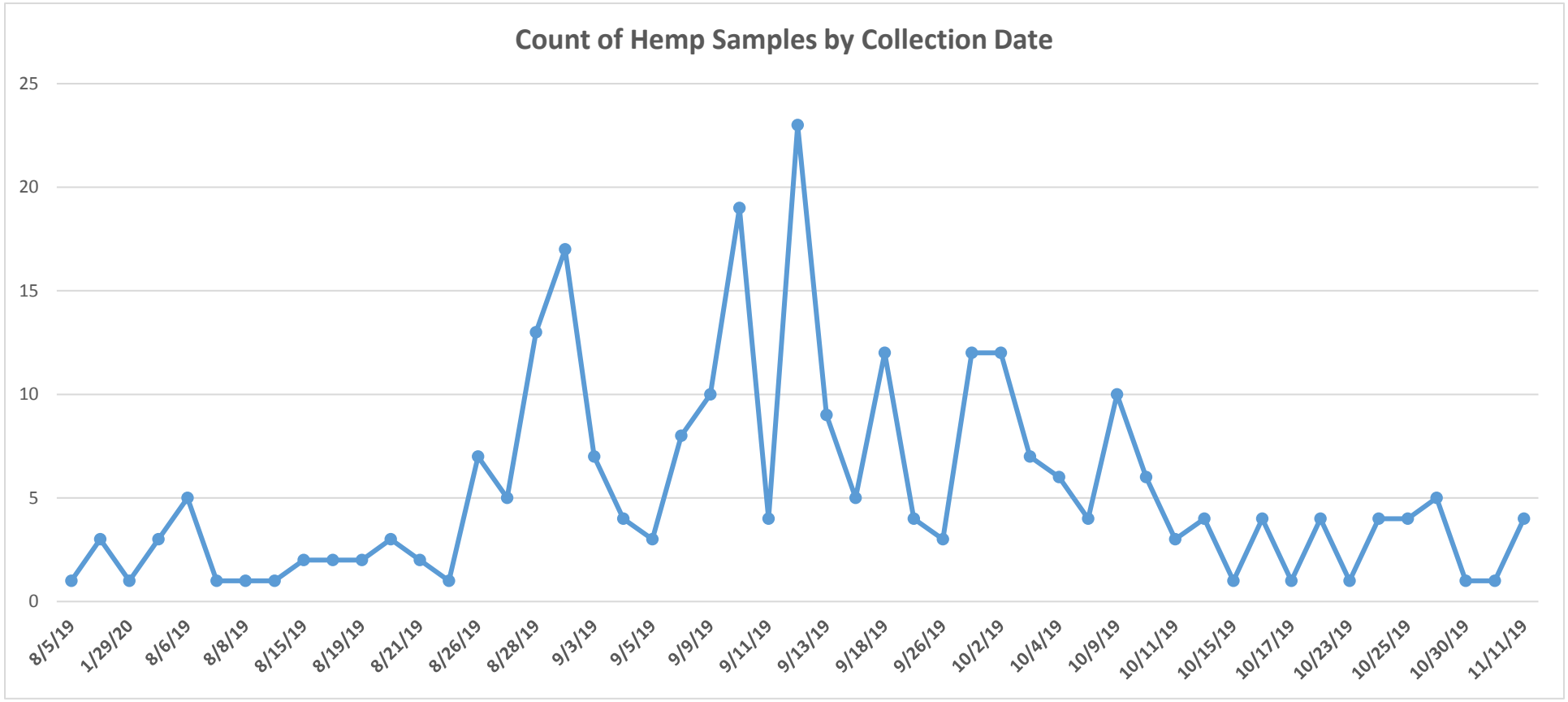
10/25/2019
10/28/2019
10/30/2019
11/4/2019
11/11/2019


Average % THC by Variety
2.50
2.00
1.50
1.00
0.50
0.00
Crs-1
Stout
T-1 (Atypical)
Citrus
Cherry Citrus
Jin Ma
Blue Haze
Blue Mammoth
Piccolo
Blue Maize
Sweets
Midwestern
Franklin
Unknown (Bushy Type)
Legacy X-59
X-59
Sweetened
T-2
Unknkown (Trump?)
Cherry Blossom
Heavenly Peppers
Boax
Cherry Bubblegum
Mojave Cherry
Orange Trumpet
Sd 1
Otto Chard
Chery Bubblegum
Merlot
Red Bordeaux
Chard Cherry
Sweets #5
Wife
Autopilot
Otto Ii Stout
Grape Soda
Cherry
Will-Lsu
Fall Bloom
Sunstrand Ss-Alpha
T-1
Young Sim 10
First Light
Cherry Wine Baox
(blank)
Cherry Uno
Unknown (Small Type)
Wu-5
Sweet
Blue Genius
Otto Ii
Indiana Velvet
Cherry Abacus
Sunstrand
Marlow
Cherry #5
Suver Haze
Hawaiian Haze
Baox
Cherry Diesel
Mammoth
First Lights
Cherry Wine
Cherry Blossum
Cherry Cherry
Abacus
Bubble Gum
Uno
Cbdrx Cherry
Sunstrand Proprietary
Pp03.24
Klr #1
Lifter
Mellow Moose
Sunstrand Fiber Hemp
Cbd Cherry Rx
26 Bx
Bubblegum
Sweetened (Cloned)
Suver
Sunstrand Seed Stock
Awesome Blossum
1681
Bubba Remedy
Delta Wine
Cherry Dc
Cinco
Trump
Liftor
Young Sim #10
Delta #5
Oregon Cherry


Count of Hemp Samples by Variety
18
16
14
12
10
8
6
4
2
0
Autopilot
Blue Genius
Blue Maize
Boax
Cbdrx Cherry
Cherry
Cherry Blossom
Cherry Cherry
Cherry Dc
Cherry Uno
Cherry Wine Baox
Delta #5
Fall Bloom
Franklin
Hawaiian Haze
Legacy X-59
Mammoth
Midwestern
Otto Chard
Sd 1
Sunstrand
Sunstrand Proprietary
Sunstrand Ss-Alpha
Suver Haze
Sweetened
Sweets #5
T-2
Unknown (Small Type)
Uno
Wu-5
Young Sim 10
T-1 (Atypical)
Mojave Cherry
First Lights
Cherry Abacus
Awesome Blossum
Marlow
Trump
Crs-1
Orange Trumpet
1681
26 Bx
Cbd Cherry Rx
Bubblegum
Liftor
Otto Ii Stout

Variety	Count of Sample Number
Autopilot	3
Baox	1
Blue Genius	1
Blue Haze	2
Blue Maize	2
Blue Mammoth	2
Boax	5
Bubba Remedy	10
Cbdrx Cherry	2
Chard Cherry	1
Cherry	4
Cherry #5	3
Cherry Blossom	11
Cherry Bubblegum	1
Cherry Cherry	1
Cherry Citrus	1
Cherry Dc	1
Cherry Diesel	1
Cherry Uno	5
Cherry Wine	17
Cherry Wine Baox	1
Citrus	1
Delta #5	3
Delta Wine	3
Fall Bloom	2
First Light	1
Franklin	1
Grape Soda	2
Hawaiian Haze	3
Heavenly Peppers	1
Legacy X-59	2
Lifter	2
Mammoth	12
Merlot	1
Midwestern	1
Oregon Cherry	11
Otto Chard	1
Red Bordeaux	1
Sd 1	1
Stout	1
Sunstrand	6
Sunstrand Fiber Hemp	4
Sunstrand Proprietary	15
Sunstrand Seed Stock	2
Sunstrand Ss-Alpha	4
Suver	1
Suver Haze	4
Sweet	9
Sweetened	7
Sweets	2
Sweets #5	1
T-1	6
T-2	3
Unknkown (Trump?)	1
Unknown (Small Type)	1
Unknown (Bushy Type)	1
Uno	16
Wife	8
Wu-5	1
X-59	5
Young Sim 10	1
(blank)	2
T-1 (Atypical)	1
Jin Ma	4
Mojave Cherry	1
Chery Bubblegum	1
First Lights	1
Cherry Blossum	1
Cherry Abacus	1
Abacus	2
Awesome Blossum	3
Indiana Velvet	1
Marlow	2
Cinco	1
Trump	6
Young Sim #10	1
Crs-1	1
Piccolo	1
Orange Trumpet	1
Otto Ii	1
1681	1
Mellow Moose	1
26 Bx	1
Pp03.24	1
Cbd Cherry Rx	2
Will-Lsu	1
Bubblegum	4
Klr #1	5
Liftor	1
Sweetened (Cloned)	1
Otto Ii Stout	1
Bubble Gum	1
Grand Total	**275**


Count of Hemp Samples by Collection Date
25
20
15
10
5
0
8/5/19
1/29/20
8/6/19
8/8/19
8/15/19
8/19/19
8/21/19
8/26/19
8/28/19
9/3/19
9/5/19
9/9/19
9/11/19
9/13/19
9/18/19
9/26/19
10/2/19
10/4/19
10/9/19
10/11/19
10/15/19
10/17/19
10/23/19
10/25/19
10/30/19
11/11/19

Collection Date	Count of Sample Number
8/5/19	1
1/27/20	3
1/29/20	1
1/30/20	3
8/6/19	5
8/7/19	1
8/8/19	1
8/9/19	1
8/15/19	2
8/16/19	2
8/19/19	2
8/20/19	3
8/21/19	2
8/22/19	1
8/26/19	7
8/27/19	5
8/28/19	13
8/29/19	17
9/3/19	7
9/4/19	4
9/5/19	3
9/6/19	8
9/9/19	10
9/10/19	19
9/11/19	4
9/12/19	23
9/13/19	9
9/17/19	5
9/18/19	12
9/20/19	4
9/26/19	3
10/1/19	12
10/2/19	12
10/3/19	7
10/4/19	6
10/7/19	4
10/9/19	10
10/10/19	6
10/11/19	3
10/14/19	4
10/15/19	1
10/16/19	4
10/17/19	1
10/22/19	4
10/23/19	1
10/24/19	4
10/25/19	4
10/28/19	5
10/30/19	1
11/4/19	1
11/11/19	4
Grand Total	**275**

Pass/Fail by Variety	Count of Sample Number
FAIL	**96**
1681	1
26 Bx	1
Abacus	1
Awesome Blossum	3
Bubba Remedy	9
Cbd Cherry Rx	2
Cbdrx Cherry	1
Cherry #5	1
Cherry Blossom	1
Cherry Dc	1
Cherry Wine	6
Cinco	1
Delta #5	3
Delta Wine	3
Lifter	1
Mammoth	5
Mellow Moose	1
Oregon Cherry	11
Pp03.24	1
Sunstrand	1
Sunstrand Fiber Hemp	3
Sunstrand Proprietary	9
Sunstrand Seed Stock	1
Sunstrand Ss-Alpha	1
Suver	1
Sweet	1
Trump	6
Uno	7
Wife	1
Young Sim #10	1
(blank)	2
Bubblegum	3
Klr #1	3
Liftor	1
Sweetened (Cloned)	1
Bubble Gum	1

Pass/Fail by Variety	Count of Sample Number
PASS	**179**
Abacus	1
Autopilot	3
Baox	1
Blue Genius	1
Blue Haze	2
Blue Maize	2
Blue Mammoth	2
Boax	5
Bubba Remedy	1
Cbdrx Cherry	1
Chard Cherry	1
Cherry	4
Cherry #5	2
Cherry Abacus	1
Cherry Blossom	10
Cherry Blossum	1
Cherry Bubblegum	1
Cherry Cherry	1
Cherry Citrus	1
Cherry Diesel	1
Cherry Uno	5
Cherry Wine	11
Cherry Wine Baox	1
Chery Bubblegum	1
Citrus	1
Crs-1	1
Fall Bloom	2
First Light	1
First Lights	1
Franklin	1
Grape Soda	2
Hawaiian Haze	3
Heavenly Peppers	1
Indiana Velvet	1
Jin Ma	4
Legacy X-59	2
Lifter	1
Mammoth	7
Marlow	2
Merlot	1
Midwestern	1
Mojave Cherry	1
Orange Trumpet	1
Otto Chard	1
Otto Ii	1
Piccolo	1
Red Bordeaux	1
Sd 1	1
Stout	1
Sunstrand	5
Sunstrand Fiber Hemp	1
Sunstrand Proprietary	6
Sunstrand Seed Stock	1
Sunstrand Ss-Alpha	3
Suver Haze	4
Sweet	8
Sweetened	7
Sweets	2
Sweets #5	1
T-1	6
T-1 (Atypical)	1
T-2	3
Unknkown (Trump?)	1
Unknown (Small Type)	1
Unknown (Bushy Type)	1
Uno	9
Wife	7
Will-Lsu	1
Wu-5	1
X-59	5
Young Sim 10	1
Bubblegum	1
Klr #1	2
Otto Ii Stout	1
Grand Total	**275**

Pass/Fail by Percentage	Count of Sample Number
FAIL	96
Pass	179
Grand Total	**275**

Pass/Fail by 0.3% Criteria	Count of Samples
FAIL	130
PASS	145
Grand Total	**275**

Pass/Fail by 0.4% Criteria	Count of Sample Number
FAIL	96
Pass	179
Grand Total	**275**

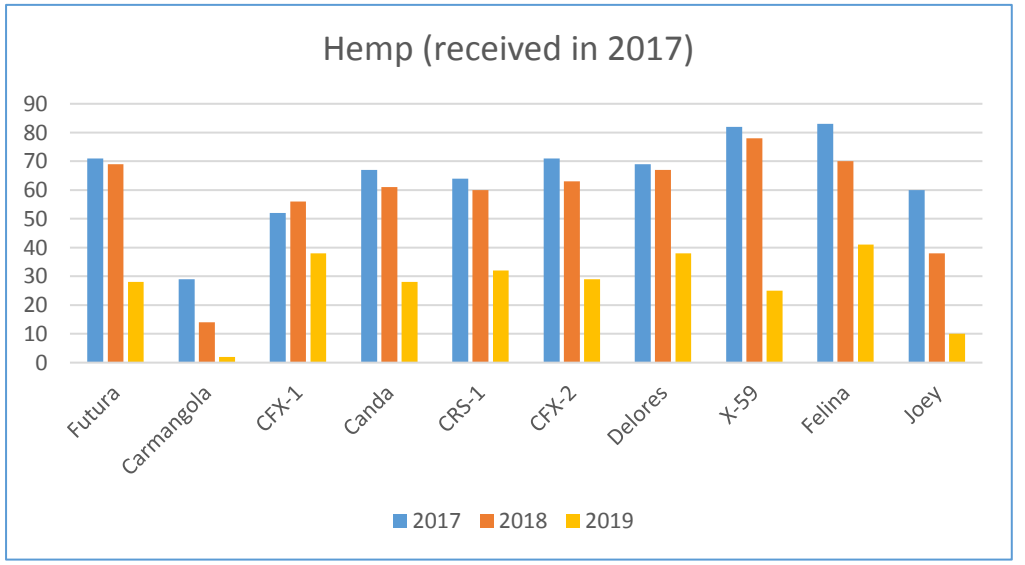
Pass/Fail by Collection Date	Count of Sample Number
FAIL	**96**
8/5/2019	1
1/27/2020	2
1/30/2020	1
8/6/2019	2
8/8/2019	1
8/16/2019	1
8/21/2019	2
8/28/2019	1
8/29/2019	1
9/4/2019	3
9/9/2019	3
9/10/2019	3
9/11/2019	4
9/12/2019	6
9/17/2019	2
9/18/2019	4
9/26/2019	2
10/2/2019	6
10/3/2019	3
10/7/2019	4
10/9/2019	7
10/10/2019	6
10/11/2019	3
10/14/2019	4
10/16/2019	4
10/22/2019	4
10/23/2019	1
10/24/2019	4
10/25/2019	3
10/28/2019	3
10/30/2019	1
11/11/2019	4

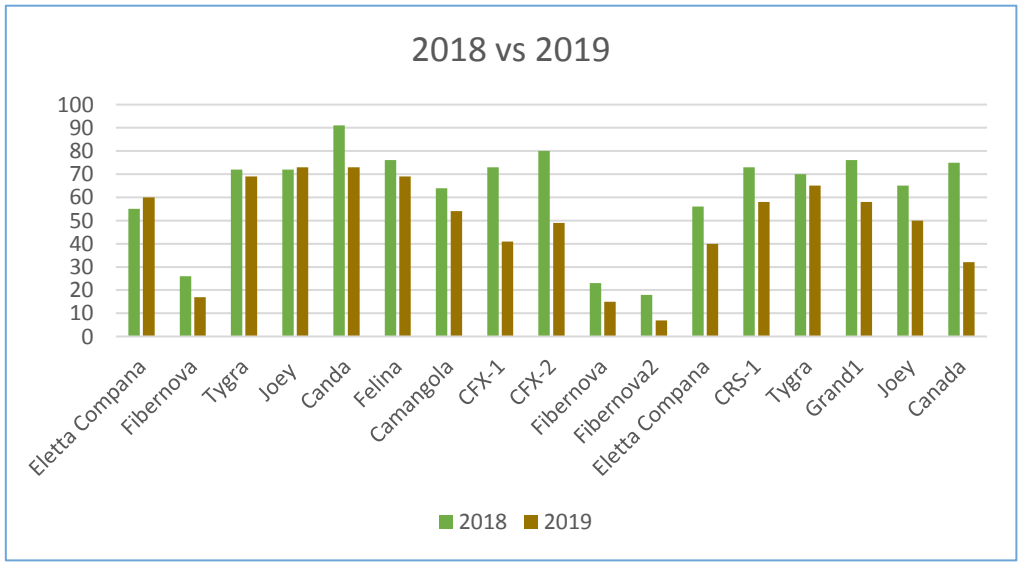
Pass/Fail by Collection Date	Count of Sample Number
Pass	**179**
1/27/2020	1
1/29/2020	1
1/30/2020	2
8/6/2019	3
8/7/2019	1
8/9/2019	1
8/15/2019	2
8/16/2019	1
8/19/2019	2
8/20/2019	3
8/22/2019	1
8/26/2019	7
8/27/2019	5
8/28/2019	12
8/29/2019	16
9/3/2019	7
9/4/2019	1
9/5/2019	3
9/6/2019	8
9/9/2019	7
9/10/2019	16
9/12/2019	17
9/13/2019	9
9/17/2019	3
9/18/2019	8
9/20/2019	4
9/26/2019	1
10/1/2019	12
10/2/2019	6
10/3/2019	4
10/4/2019	6
10/9/2019	3
10/15/2019	1
10/17/2019	1
10/25/2019	1
10/28/2019	2
11/4/2019	1
Grand Total	**275**

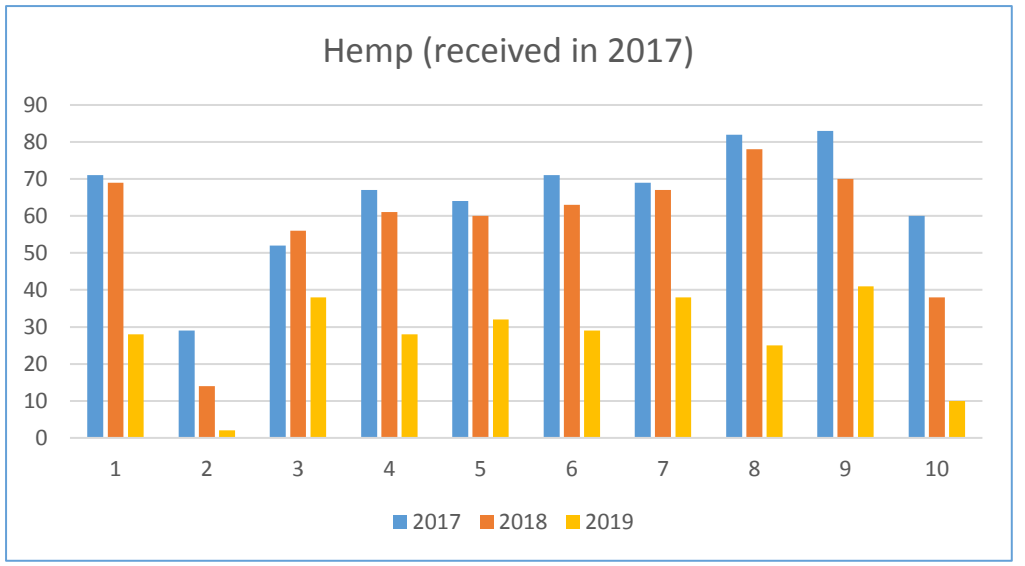
Hemp Seed Germination Results from Indiana State Seed Lab - Fiber/Grain Varieties

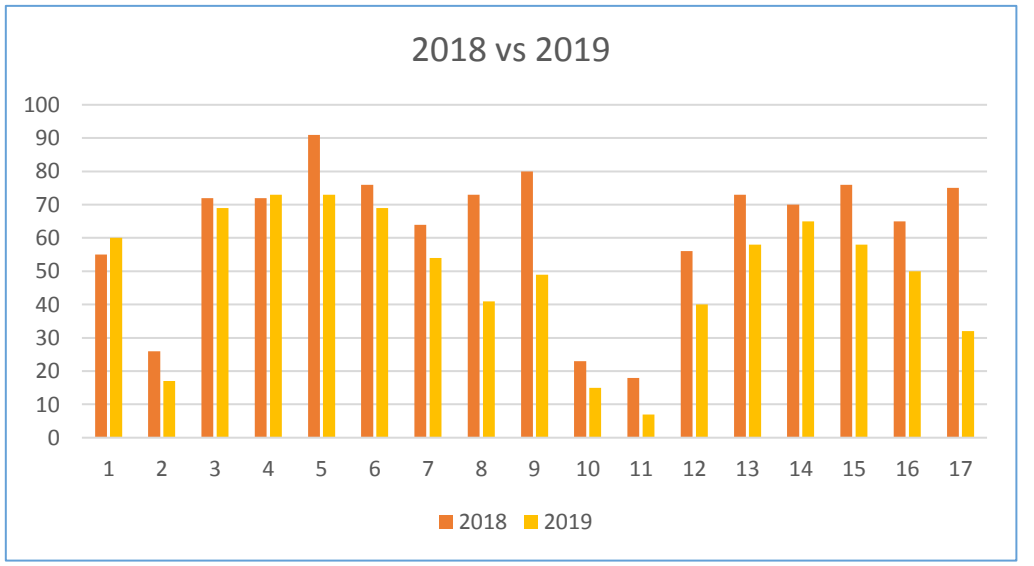
	Variety		2017	2018	Spring 2019	Summer 2019	Dif btwn 2018 & 2019	Dif btwn 2017 & 2019
B19-633	Eletta Compana	1		55		60	-5	
B19-634	Fibernova	2		26		17	9	
B19-635	Tygra	3		72		69	3	
B19-636	Joey	4		72		73	-1	
B19-637	Canda	5		91		73	18	
B19-638	Felina	6		76		69	7	
B19-639	Camangola	7		64		54	10	
B19-640	CFX-1	8		73		41	32	
B19-641	CFX-2	9		80		49	31	
B19-642	Fibernova	10		23		15	8	
B19-643	Fibernova2	11		18		7	11	
B19-644	Eletta Compana	12		56		40	16	
B19-645	CRS-1	13		73		58	15	
B19-646	Tygra	14		70		65	5	
B19-647	Grand1	15		76		58	18	
B19-648	Joey	16		65		50	15	
B19-649	Canada	17		75		32	43	
B19-650	Farmer Sample				81	88		
B19-651	X59				83	49		
B19-652	X59				75	59		
B19-653	X59				90	52		
B19-654	X59				75	61		
B19-655	Futura	1	71	69		28	41	43
B19-656	Carmangola	2	29	14		2	12	27
B19-657	CFX-1	3	52	56		38	18	14
B19-658	Canda	4	67	61		28	33	39
B19-659	CRS-1	5	64	60		32	28	32
B19-660	CFX-2	6	71	63		29	34	42
B19-661	Delores	7	69	67		38	29	31
B19-662	X-59	8	82	78		25	53	57
B19-663	Felina	9	83	70		41	29	42
B19-664	Joey	10	60	38		10	28	50
			64.8	60.77778	80.8	44.0625	20	37.7

Hemp Seed Germination Results from Indiana State Seed Lab - Fiber/Grain Varieties









Outcomes from 2019 hemp research reports have been summarized into six categories; economics and labor, seeds and clone quality, agronomics and production, equipment and processing, THC and CBD content and testing, and pests.

Marguerite Bolt, Purdue Agronomy
Don Robison, Office of Indiana State Chemist Seed Administrator

ECONOMICS AND LABOR

Labor needs were overall underestimated and required more resources than budgeted for.

1. Labor sources ranged from veterans with PTSD, to children to traveling crews. Labor is a major investment for many in this new industry. Typically, labor costs exceeded budget.
2. A major outlay of cash for processing equipment was a consistent story in the reports. Over budget were two often used words when talking about labor and equipment.
3. Several growers were not paid for their crop, either through a contract grow agreement or through a processor that didn't live up to an agreement to buy.
4. Economic issues were widespread, it was recommended by one grower to set up an escrow account for payments to suppliers that isn't released until the supplier provides the quantity of plants contracted.
5. Labor was a much bigger issue than was planned for, particularly in weed control.
6. Labor, in some cases up to 60 part-time employees.

SEED AND CLONES

Quality in both seeds and clones varied greatly. Mis-advertising of seed was a common issue in regard to germination and feminization. Varieties different than what was expected.

1. Field seed germination rates ranged wildly, from a claimed low of 5% to claimed high of 95%.
2. Feminized seed claims were not met in most cases, either in germination rates or in % that was feminized.
3. Poor quality clones and cuttings was a consistent story from the 2019 season. Suppliers not being able to keep up with seasonal demand and the lack of high quality starts set several dozen growers back. Also a high death rate of clones and cuttings was reported.
4. Is the plant a girl or a boy? Not always easy to tell but very important in a CBD growth environment.
5. Seed was not as advertised.
6. Germination rate testing "on farm" shows poor results from CBD plants that went to seed.
7. Very different phenotypes were found within the same variety.
8. Multiple production issues out of poor clone health from supplier. Over 40% death rate in some cases.
9. Marketing material on seed and on varieties are typically not accurate.

10. Found some varieties that did well in the western US do not do well in Indiana.
11. Different varieties mature at different times.

EQUIPMENT AND PROCESSING

Most growers tried to understand how to plant and harvest hemp using their current farming equipment.

1. Like Varieties, hemp specific equipment also did not live up to claims consistently.
2. Different types of haying equipment showed variable effectiveness with the fiber hemp crop.
3. Several steps tested to help automate harvest were not as effective as doing the work by hand.
4. Many different kinds of existing farm equipment was used for harvesting biomass, combine, stripper, silage chopper, sickle bar, etc.
5. Additions and adjustments to existing farm equipment had to be made to automate processes of planting.
6. Had trouble baling the fiber.
7. Harvest of grain crops was successful using a draper header or flex draper header.
8. Combine does a nice job, but need to get air on the seed quickly to keep from molding.
9. Trial of harvesting seed a fiber from same plant, no economic way to harvest separately.
10. Post-harvest drying consisted of both hang drying and mechanized drying. Environmental conditions contribute to drying speed.
11. Drying facility size is a bottleneck.
12. Drying was done by hanging and with mechanized drying, mechanized drying did a nice job of keeping biomass from molding.
13. Drying space for hanging CBD crops consistently takes more space than estimated, up to 30sqft/mature plant.
14. Difficult time finding a shipper.
15. With temps under 70 degrees and humidity under 10% it took six days to take the plants from 80% moisture down to 10% moisture when hung dried.
16. Drying of grain crops started at around 15% moisture in drying floor grain bins. Important to keep grain level.

OUTDOOR AND INDOOR MANAGEMENT

Selecting optimal field sites and preparing them for planting was an important step for success. Fertility studies included many different types of fertilizer in both till and no-till systems. The source of water was important for plant quality as well as the amount of water plants received. Indoor management research focused on growing media, lighting, and propagation.

1. Soil preparation is consistently mentioned in research reports as a critical factor that affects quality of plants.
2. A no-till approach can be successful, even advantageous.

3. Wet soils resulted in a 50% stand.
4. Needs to be put on well drained silt loam or sandy loam soils, heavy soils did not perform well, some reported it does better with high organic matter in soils.
5. Compared plastic raised beds with direct seeding and no plastic. In this case direct seeding produced a higher yield.
6. Many had success with raised beds and plastic in drip tape irrigation.
7. Row spacing trials seemed to focus on an optimal width of around 60 inches if raised on plastic.
8. Some success managing hemp in a similar way to corn.
9. An issue for the industry to watch is pollen movement, it is highly mobile.
10. Still unknown how far pollen will travel, at least 5 miles confirmed.
11. Days to maturity from seed was quicker than for fiber.
12. Planting populations went from 1200 plants per acre to over 4000 plants per acre from seed.
13. Harvest time after flowering varied greatly from variety to variety and even phenomes within a variety.

FERTILITY

1. Nitrogen rates in no-till vs tilled fields showed different levels of response. Many different kinds of fertilizer were used. Dry, liquid, micros, organic, chicken litter, conventional, plant growth substances, foliar, alfalfa meal, humic acid.
2. Micronutrient packages were widely varied from none at all to over 150lbs of micronutrients per acre.
3. Foliar applied fertilizer that was not meant for foliar feeding did not respond well and burnt up a high percentage of plants. Fertility trials based on commercial fertilizer regimen and a chicken manure regimen.
4. Nitrogen, boron, magnesium were found to be limiting factors based on leaf tissue analysis.
5. Several fertility trials with mixed results.

WATER

1. Water pH is important in cloning.
2. Soil and water pH levels are very important, several reports discussed this even though it was not part of the primary study, the failure of some crops was a result of too high of pH in both soil and water.
3. Water sources ranged from an above ground pool to new wells dug for this purpose to above ground tanks.
4. In dry times, even the morning dew seems to help the plant grow.
5. Irrigation had to be conducted multiple times as the summer got dry.

INDOOR MANAGEMENT

1. Studied differing climate control temperatures during different life cycles.
2. Studied multiple different spectrums of light.
3. Light timing trials were consistent among the group.
4. Lighting types were studied by several growers in 2019.
5. Multiple different soil and soilless mixes were tested, some did well, peat based organic soils did not do well in some trials, coco coir substrates performed well.
6. Grow container sizes were studied by some growers.
7. Organic rooting hormones found in powdered aloe had good results as compared with an aeroponic cloner.
8. Super Cropped plants to try to increase number of buds per plant.

PESTS

Weed pressure, insect and mite pests, and pathogens were all important aspects of hemp research in 2019. Different weed management strategies were used in both conventional and organic sites. Pressure form insects and mites were apparent, while damage from wildlife was not. Botrytis was a prevalent disease found in hemp. Some growers found that the crop grown in the previous year impacted the pathogen pressure in their hemp fields.

WEEDS

1. Weed eaters, mowers, roto-tillers, and bush hogs were the most consistently used forms of weed control besides hand tools.
2. Early weed control is critical in outdoor production.
3. Organic fields in some cases ran out of nitrogen, causing a lack of competition against weeds.
4. Organic fields had many more weed seeds in the harvested grain fields, in excess of 50% of the harvested material, must clean the grain quickly before drying?
5. Weed pressure was a constant battle in seed planted fields.
6. Weeds were a major problem.
7. Seeding rates on fiber crops were critical for weed control. Target seeding rate of 75lbs/acre showed good weed control. Rates as low as 40-50lbs/acre.

INSECTS AND MITES

1. Corn ear worm was a major problem in nearly every plot.
2. A controlled study of aphids preference to certain varieties was done.
3. Spider mites and caterpillars seemed to be a problem for some growers.
4. Clones received had russet mites.
5. Study of wildlife damage or consumption of plants showed very little consumed, and not much damage from stepping on or digging up the plants.

PATHOGENS

1. Botrytis was a major pathogen problem.
2. More success was had following corn in the area of pathogens than when following soybeans.

THC & CBD CONTENT AND TESTING

THC and CBD content varied greatly across varieties. Testing results differed between labs and extensive testing was costly.

1. A wide range of total THC levels and CBD levels were found. rough estimates of the average across all reports on CBD% would be around 8%. THC levels can be found in the OISC results in this state report.
2. Some varieties test very hot consistently. Entire crops were destroyed after commercial testing was done. Some varieties tested nearly 4% total THC.
3. For THC compliant plants the CBD % ranged between 4% and 12%.
4. Most high CBD crops also exceeded the legal THC limit and had to be destroyed, harvest and testing times are key to a successful crop.
5. For some, destroying flower quality.
6. Some varieties had multiple phenomes.
7. Variability in phenotype and total cannabinoid/THC levels between plants is shocking.
8. Will plan on using different commercial labs for faster turnaround.
9. The most extensive flower testing looked for over 70 pesticides, Microbial analytes, Mycotoxins and heavy metals with costs being around $700.

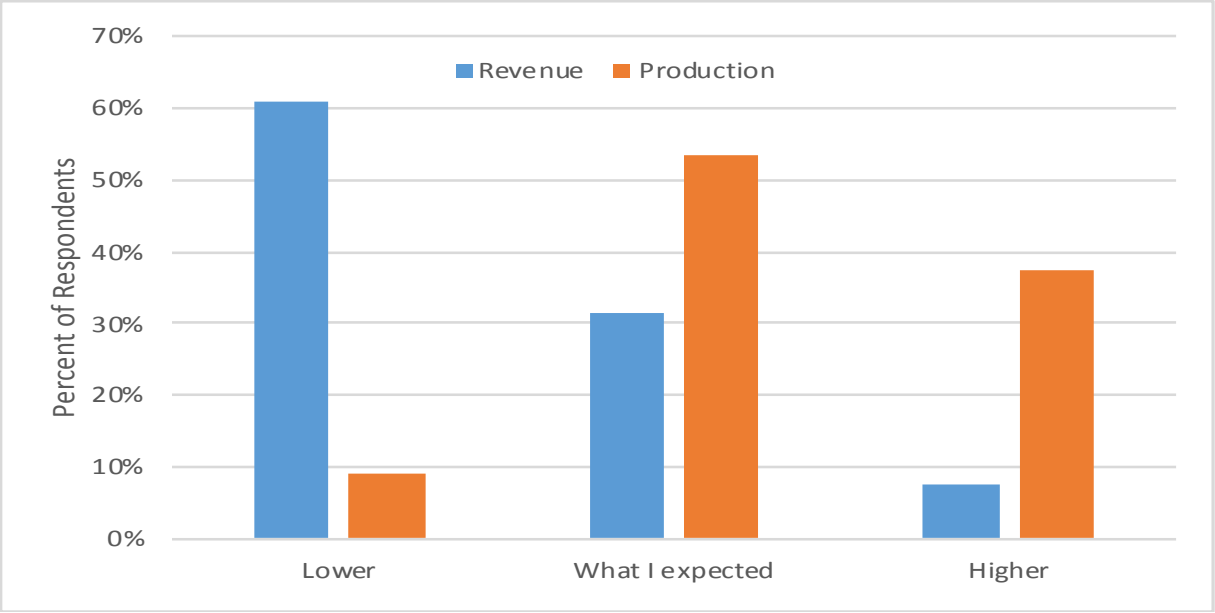
Hemp Report-Economics

Maria Marshall, Purdue Ag Economics

This report is based on the end of year survey of Indiana hemp licensees.

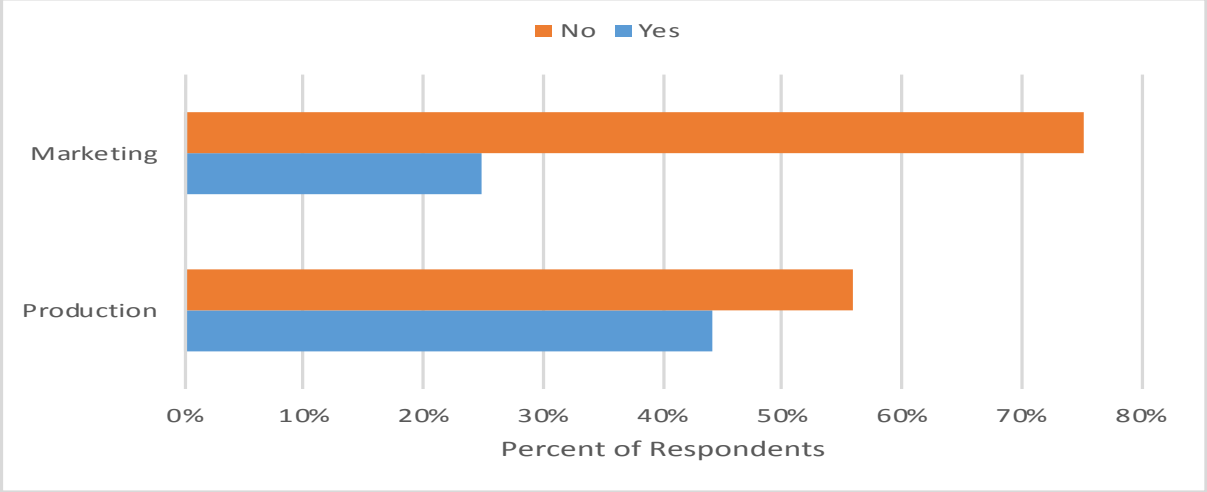
Revenue was higher for only 8% of respondents and 61% of responded that their revenue was lower than they expected (figure 1). The opposite was true for expected costs. Nine percent stated that their costs were lower than expected and 38% stated that costs were higher than expected. Costs were as expected for 53% of respondents. These results indicate that while hemp licensees had good handle on costs, they overestimated the revenue they could achieve.

Figure 1. Hemp cost and revenue expectations



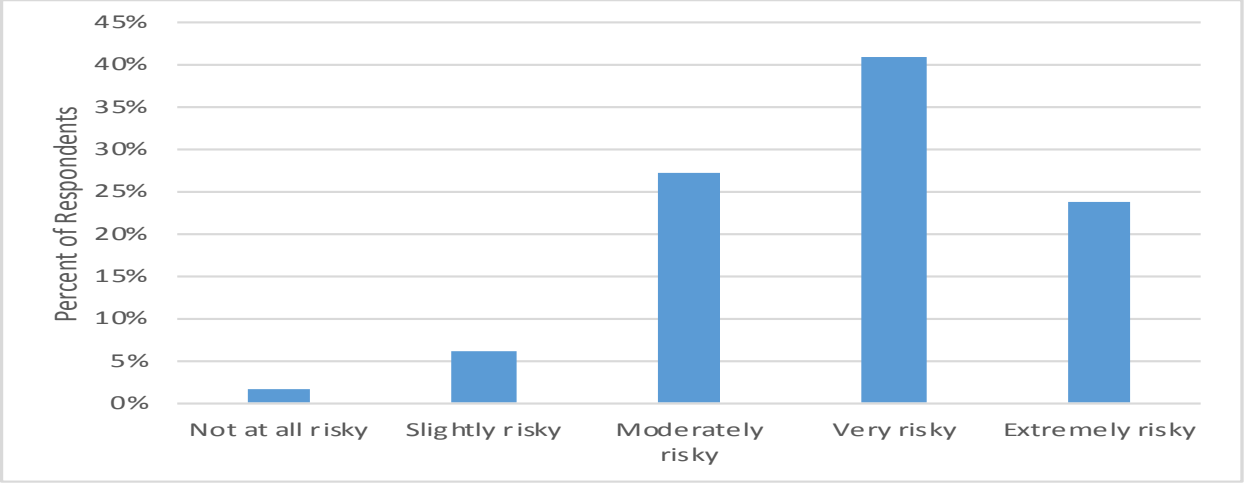
Hemp licensees seem to have an aversion to both production and marketing contracts (figure 2). Fifty-six percent of respondents had no production contract and 75% had no marketing contract. This may be correlated with 33% of respondents still looking for a processor. Interestingly, 21% of respondents stated that they were not at all likely to enter into a production contract in 2020 and 29% of respondents stated they were not at all likely to enter into a marketing contract in 2020 (figure 2).

Figure 2. Licensees with production or marketing contracts



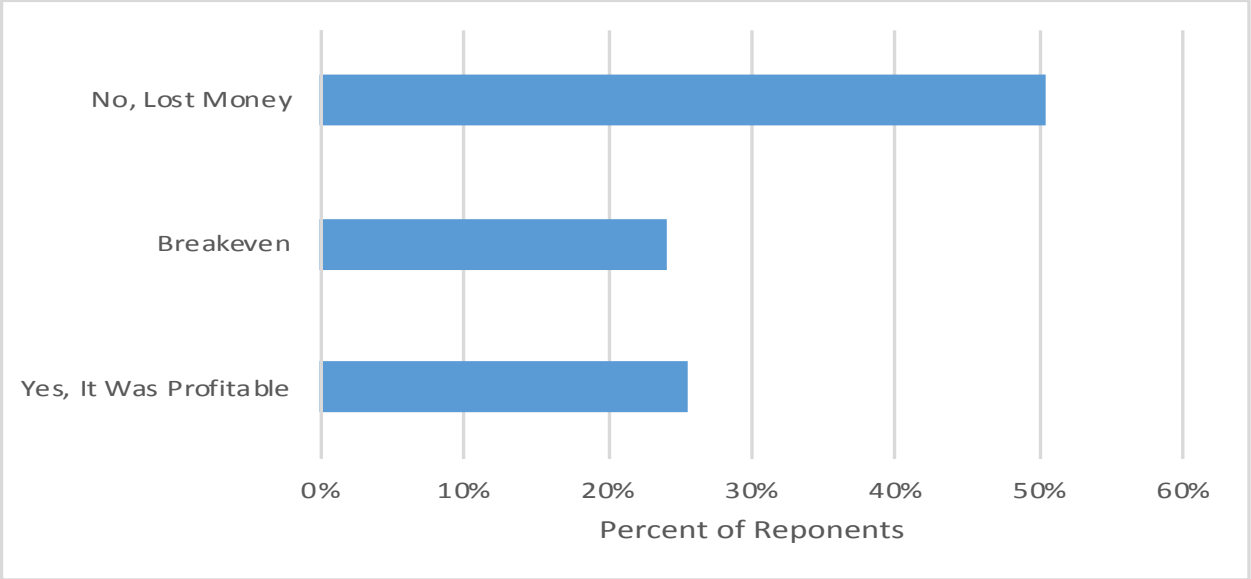
Certainly, hemp licensees understand that this new and growing market can be risky (figure 3). In fact, 65% of respondents indicated that they perceived the hemp market to be very or extremely risky.

Figure 3. Do you think the hemp market is risky?



As figure 4 shows, 50% of respondents stated that they were no profitable, 24% stated that they broke even, and 26% stated that they were profitable. Yet, 84% stated that they would probably or definitely grow hemp again in 2020.

Figure 4. Was 2019 a profitable hemp crop for you?



HEMP REPORT - INSECTS AND MITES

Marguerite Bolt, Purdue Agronomy

This report is based on the end of year survey distributed to Indiana hemp licensees.

Insects and mites are found in outdoor and indoor hemp environments. We see pests, natural enemies, and pollinators in production for fiber, seed, and cannabinoids/essential oils. The results covered in this section will focus on pests, natural enemies, and pollinators.

Growers were asked to identify insect and mite pests found on different parts of their hemp plants including flowers/seed heads, leaves, stems and roots. Known pests of hemp were included and growers could select more than one option. A pictorial guide was given to every grower to assist with identification. Not every licensee answered the insect and mite related questions. There were 243 total surveys collected, but we did not see any of the insect and mite questions get responses from all 243 growers. This could be explained by the type of production (indoor growers will likely not observe corn earworm or Eurasian hemp borer) or because the license holder was a processor or research advisor. Some growers may not have scouted during the field season or if they did, they did not observe the specific insects and mites provided in the survey. This survey data will help us understand the pertinent pests and beneficial organisms observed in 2019 and prepare us for what could expect in 2020.

Flower/Seed Head Pests

There are two particularly damaging flower feeding pests found in Indiana hemp, corn earworm (*Helicoverpa zea*) and Eurasian hemp borer (*Grapholita delineana*). There were 79 respondents that observed one or both of these flower chewing insects, resulting in 87 responses. The most commonly observed pest found in flowers (for cannabinoid production) and seed heads (for grain production) was the corn earworm, representing 84% of the observations (n=87). There has been considerable effort get insecticides labeled for hemp; we will have several biopesticides (fungi, viruses, bacteria) available for corn earworm management in 2020 for Indiana hemp. Please visit the OISC Pesticide Section to view these products.

A smaller percentage of respondents observed Eurasian hemp borer feeding on reproductive structures of female plants, making up 16% of the observations (n=87) in outdoor hemp production. This insect can be considered both a stem and flower pest. It appears that Eurasian hemp borer tunnels into small branches until female plants begin to flower. During the reproductive stage of hemp, larvae can be found boring into the base of flowers where they feed from the inside out, causing direct damage to the most valuable part of the plant. Because of this stalk and flower feeding behavior, you will also see Eurasian hemp borer included in the stalk boring pest section.

Leaf Chewing Pests

The most commonly observed leaf chewing pests were predominately moth larvae frequently found in the Indiana landscape. There were 81 respondents that observed one or more of the leaf chewing pests listed below, resulting in 109 responses. 36% of the observed leaf chewing pests were fall armyworm (*Spodoptera frugiperda*), 23% were yellow striped armyworm (*Spodoptera ornithogalli*), and 20% were variegated cutworm (*Peridroma saucia*)(n=109). In addition to these three species, 21% of leaf chewers observed were flea beetles (n=81) (Figure 1). We have noticed that leaf damage is typically most apparent mid- to late-season when plants are large and have abundant foliage, but growers should scout early and often for pests to ensure there are not early season defoliators causing damage.

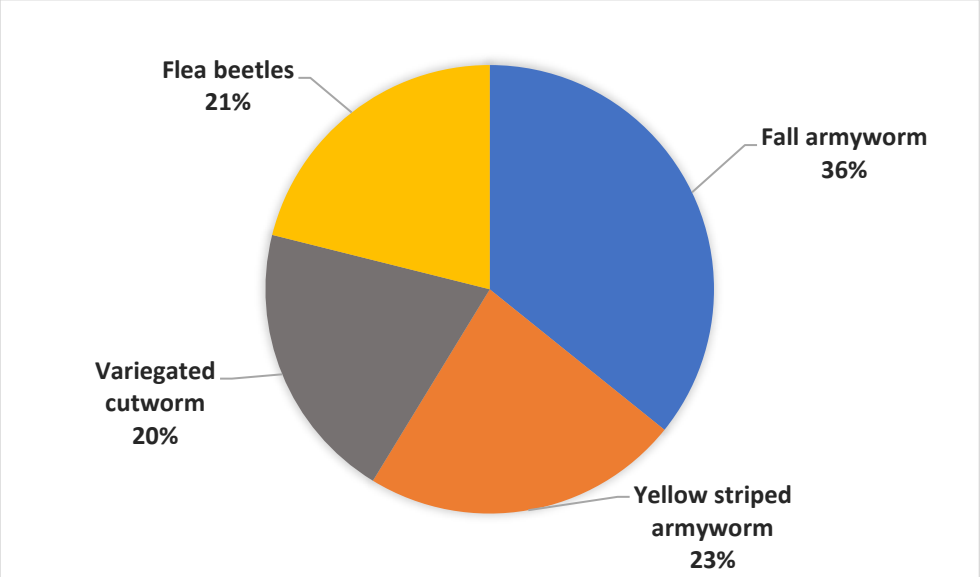


Figure 1. Common leaf chewing insects observed by Indiana hemp growers in 2019 (n=109).

Stalk Boring Pests

There are two stalk boring pests found in Indiana hemp at this point, European corn borer (*Ostrinia nubilalis*) and Eurasian hemp borer (*Grapholita delineana*). There were 44 respondents that observed one or both of the stalk boring insects found in Indiana, resulting in 52 responses. The most commonly observed stalk boring pest found by respondents was the European corn borer, representing 79% of the observations, while Eurasian hemp borers represented 21% of observations (n=52). Neither European corn borer nor Eurasian hemp borer appeared to cause much damage early in the season, however some growers did notice minor dieback of branches due to tunneling damage. The concern with Eurasian hemp borer is late season damage to female flowers (see Flower/Seed Head Pests).

Root Feeding Pests

We asked growers if they observed any root feeding insects. 86% of respondents said no, they did not observe such pests, while 14% said they did observe root feeding insects, such as fungus gnats (n=140). Of the respondents that observed root feeding pests, 75% of them were producing hemp in a controlled environment (Figure 2). Fugus gnats are common in indoor production systems, so it is not surprising that indoor growers observed this pest. There are other root pests of hemp, including nematodes, however, we did not get any reports of nematode damage.

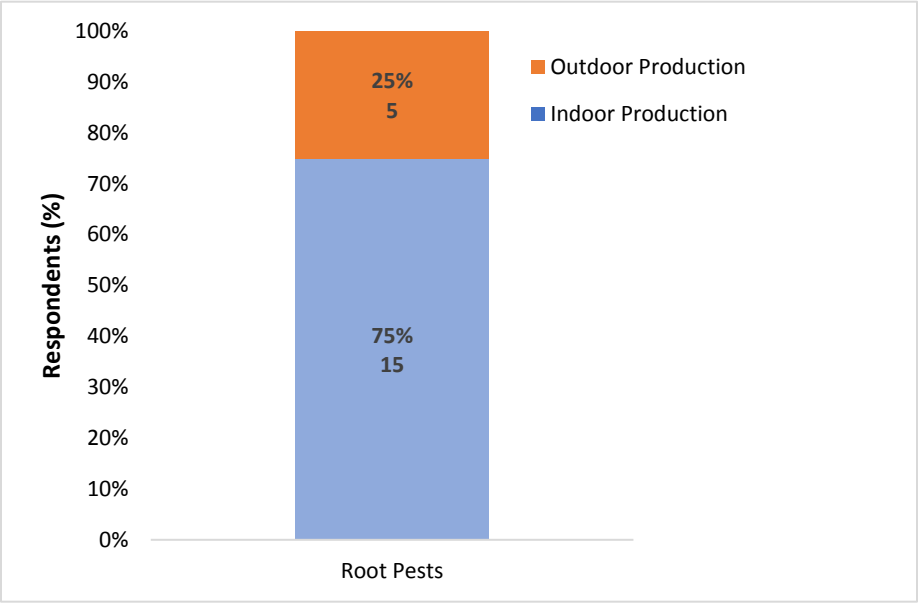


Figure 2. Percentage of indoor or outdoor hemp producers that observed root pests (n=20).

Fluid Sucking Pests

We asked growers to identify the fluid sucking pests they observed on hemp. There were 104 respondents that observed one or more of the fluid sucking pests listed below, resulting in 213 responses. The most commonly observed pests that suck fluid from hemp plants were aphids (31%), followed by stink bugs (21%), and spider mites (*Tetranychus urticae*) (17%) (n=213). Other observed pests included thrips (9%), whiteflies (7%), potato leafhopper (*Empoasca fabae*) (7%), hemp russet mites (*Aculops cannibicola*) (5%), and lygus bugs (2%) (Figure 3).

Outdoor producers observed pests like aphids, spider mites, hemp russet mites, thrips, and whiteflies as much or more than indoor producers (Figure 4). However, anecdotally, all of these pests tend to be associated more strongly with indoor hemp production. We were surprised to see that observations were not higher in indoor production. Because these pests are found in both indoor and outdoor production, different management techniques will need to be developed to minimize infestations. Pests like hemp russet mites and cannabis aphid are easily moved from facility to facility or field on plant material, supplies, and clothing. Following good sanitary practices is key for management of these pests indoors and outdoors.

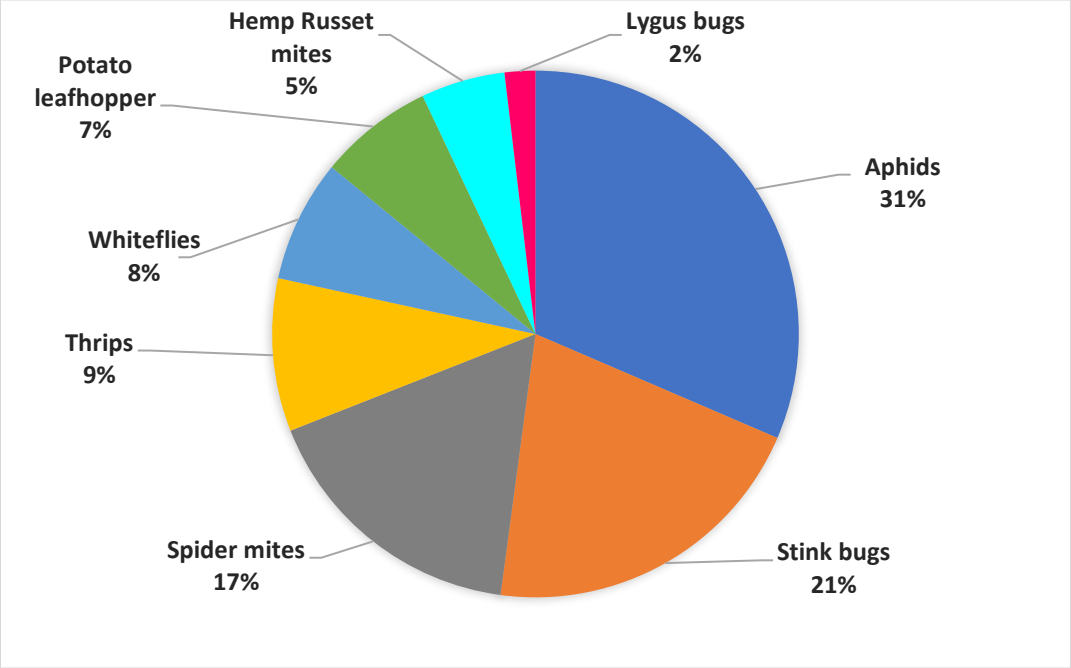


Figure 3. Fluid sucking pests observed in indoor and outdoor grown hemp in 2019 (n=213).

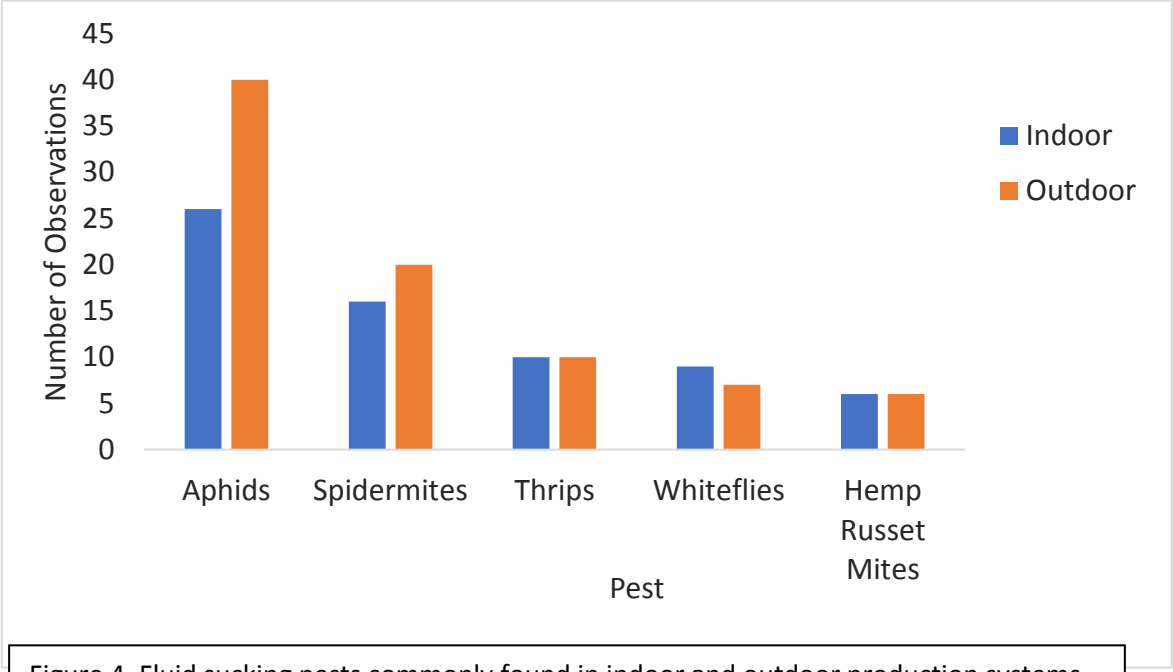


Figure 4. Fluid sucking pests commonly found in indoor and outdoor production systems

Natural Enemies and Pollinators

We asked growers to identify the natural enemies and pollinators they observed in hemp fields. There were 112 respondents that observed one or more of the natural enemies and pollinators listed below, resulting in 337 responses. The most commonly observed predators included ladybird beetles (30%), spiders (21%), and praying mantids (14%) (n=337). Respondents observed, to a lesser extent, lacewings (6%), ambush/assassin bugs (4%), minute pirate bugs (2%), long legged flies (2%), and snipe flies (1%) (Figure 5). 18% of observed beneficial organisms were bees, but we did not differentiate between species of bee. Another beneficial insect that serves as a pollinator in its adult stage but is a predator in its larval stage are syrphid or hover flies, which made up 3% of observed natural enemies and pollinators.

Maintaining healthy populations of natural enemies is important for pest control. While we do have some pesticidal products available for use in hemp now, predators and parasitoids provide free pest reduction in outdoor systems. In controlled environments, some growers introduce predators and parasitoids to keep pests and bay.

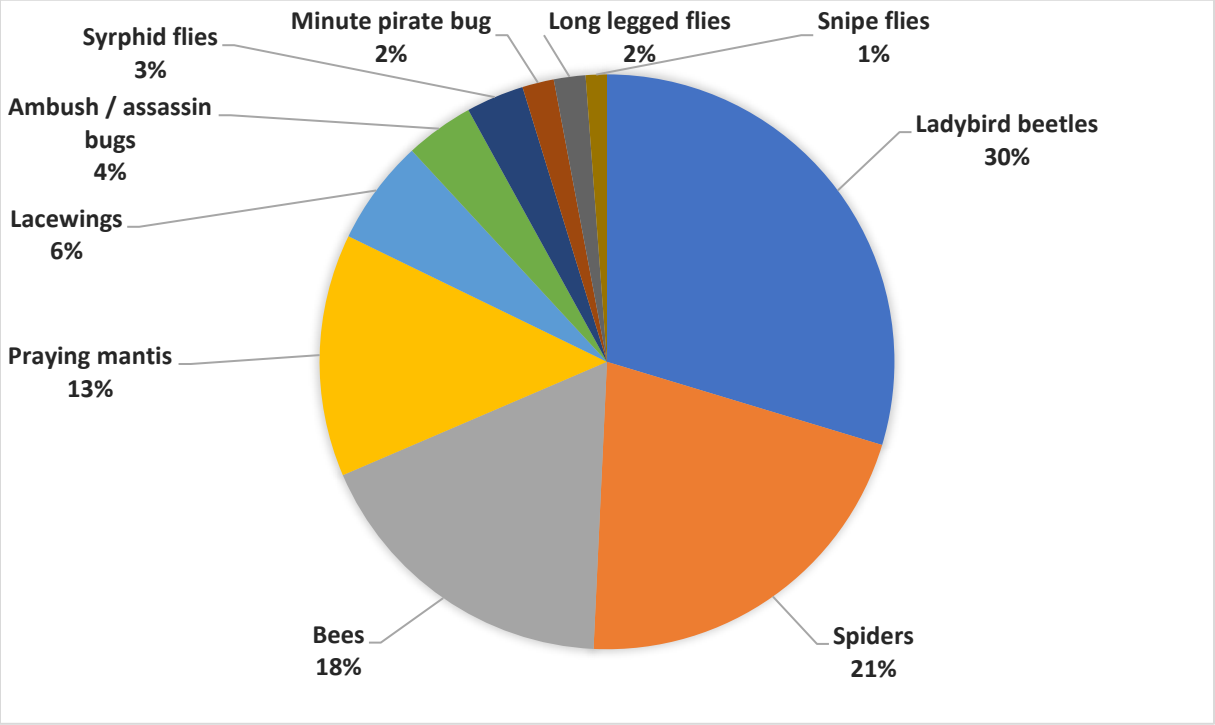


Figure 5. Common beneficial arthropods observed in hemp, including both natural enemies and pollinators (n=337).

Industrial Hemp for Fiber 2019-Southwest Purdue Agriculture Center
Nitrogen Rate X Seeding Rate

Chuck Mansfield, Purdue Agronomy

Cultural Practices

Planting Date:	5/16/2019
Tillage:	drilled into tilled seedbed
Seeding Rates:	375 K, 750 K, 1.125 M, 1.5 M live seeds per acre
Row Spacing:	6 inches
Plot Size:	9 rows X 50 feet
Harvested Area:	200 sq. ft.
Harvest Date:	8/22-23/2019
Irrigation:	none

Soil Test: P = 56 lb/ac K = 154 lb/ac pH = 6.2 OM = 1.5%

Fertilizer: Preplant urea, incorporated - 3 rates at 50, 100, 200 lb N/acre

Previous Crop: soybean

Location Description

Soil Type:	Lomax loam, well drained
Elevation:	430 ft
Latitude:	38.74 ^{o}N
Longitude:	-87.48 ^{o}W

Comments/Summary:

Stands were very good and consistent with the seeding rate.

Moderate seedling vigor. Plant health good.

Biomass production and plant height increased with increasing nitrogen rate.

Seeding rate did not affect final biomass production.

However, seeding rate does affect stem diameter. Moderate to high seeding rates produce desirable stem diameters in the 6 to 7 mm range.

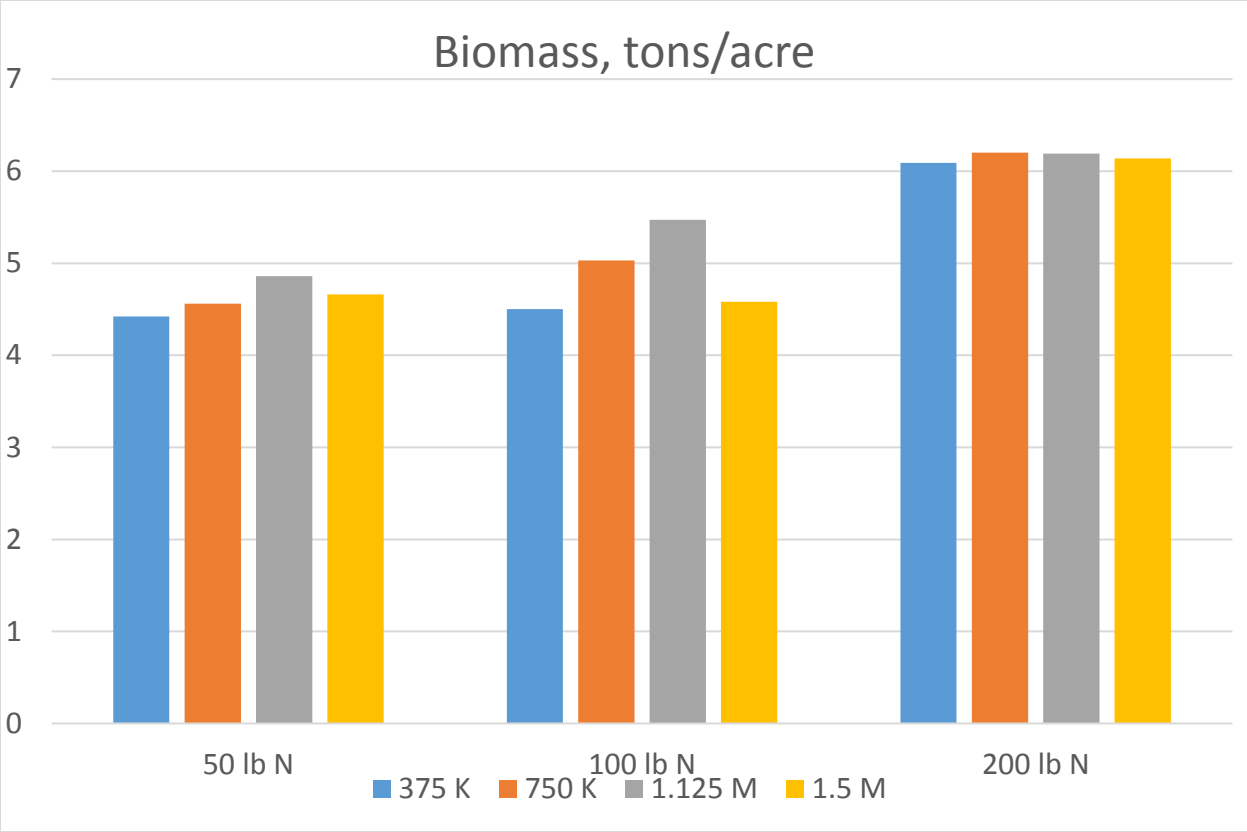
Low seeding rate produces relatively large stem diameter.

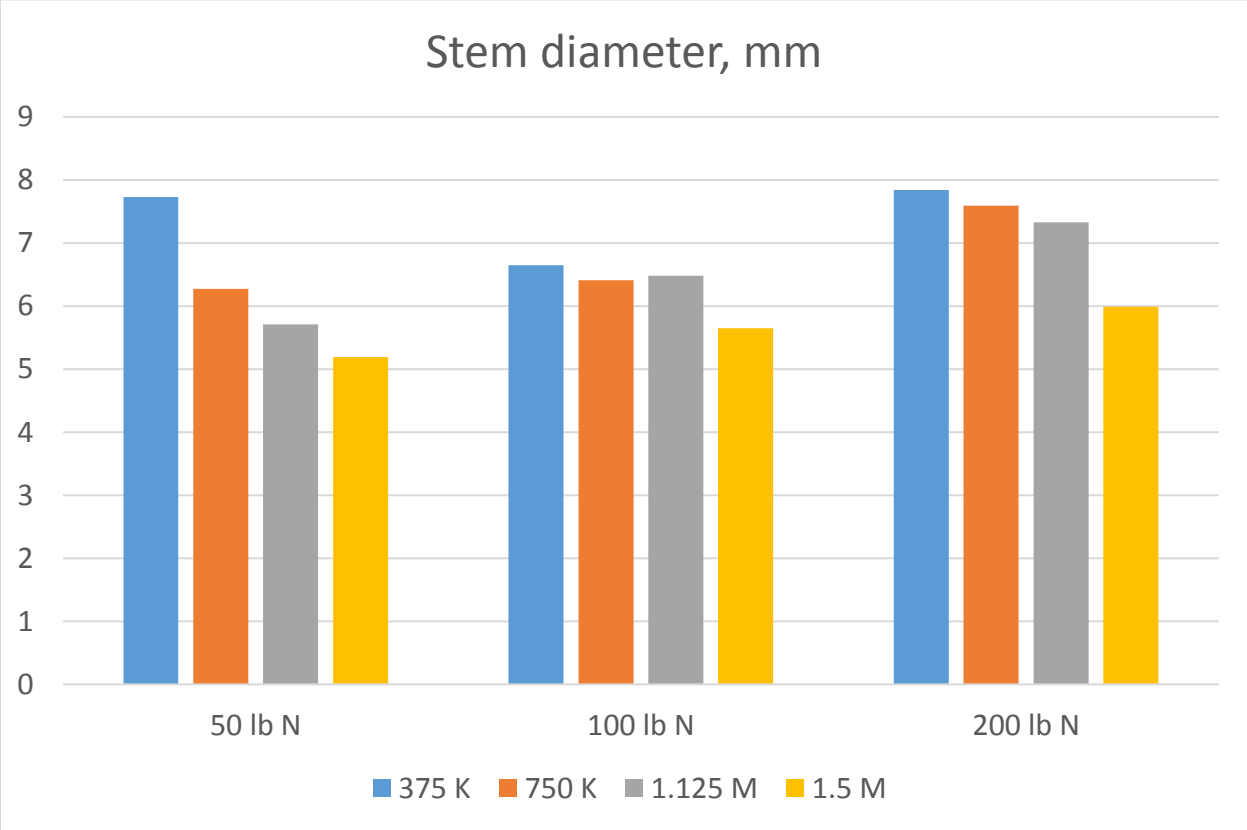
Effect of Nitrogen Rate

N Rate	Yield, T		7/10/2019 HT 1, in		8/15/2019 HT 2, in		Lodging, %		Stem dia, mm	
200	6.1	a	68	a	106	a	19.8	a	7.2	a
100	4.9	b	63	b	96	b	10.6	b	6.3	b
50	4.6	b	62	b	91	c	6.3	b	6.3	b
LSD	0.939		2.5		4.0		4.65		0.38	
C.V.	11.58		4.51		4.83		45.04		6.92	
MEAN	5.2		64.5		97.9		12.2		6.6	

Effect of Seeding Rate

Seed Rate	Yield, T		7/10/2019 HT 1, in		8/15/2019 HT 2, in		Lodging		Stem dia, mm	
1,500,000	5.1		62.6	b	92.7	c	16.9	a	5.6	c
1,125,000	5.5		64.3	ab	97.5	b	17.4	a	6.5	b
750,000	5.3		64.4	ab	98.8	ab	11.0	b	6.8	b
375,000	5		66.9	a	102.7	a	3.4	c	7.4	a
LSD	NS		2.8		4.6		5.37		0.44	
C.V.	11.58		4.51		4.83		45.04		6.92	
MEAN	5.2		64.5		97.9		12.2		6.6	


Biomass, tons/acre
7
6
5
4
3
2
1
0
50 lb N
100 lb N
200 lb N
375 K
750 K
1.125 M
1.5 M


Stem diameter, mm
9
8
7
6
5
4
3
2
1
0
50 lb N
100 lb N
200 lb N
375 K
750 K
1.125 M
1.5 M

May 24. Eight days after planting

June 18. Thirty three days after planting

August 22. End trimmed for harvest, 98 days after planting