Seeding Date, Variety, and Seed Treatment Influence on Industrial Hemp Performance in North Dakota-2019
NDSU Langdon Research Extension Center

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Cultivation of industrial hemp (*Cannabis sativa* L., THC level < 0.3%) is now legal in the U.S. with the passage of the 2018 Farm Bill. However, production requires participating in the hemp pilot program offered through the North Dakota Department of Agriculture. The last hemp production prior to 2015 was during the 1940s when fiber was needed in manufacturing supplies for U.S. forces in World War II. The U.S. 2014 and 2018 Farm Bills included provisions allowing for industrial hemp production after 70 years of prohibition. The NDSU Langdon Research Extension Center began conducting industrial hemp variety evaluations in 2015. To gain a better understanding of hemp production in North Dakota common production practices, such as proper seeding date, need to be investigated. Pure live seedling emergence (PLSE) of industrial hemp is lower, often substantially, than for wheat, soybean, and corn and most other agronomic crops where 85% or greater PLSE is common and expected under average to good growing conditions. Fungicide seed treatments are a common cost effective practice for improving PLSE in crops and they become more important when stand establishment conditions are less than ideal. There are no labeled fungicide seed treatments currently available for industrial hemp in the USA. The objective of this study was to evaluate seeding date, variety, and seed treatment effects on industrial hemp stand establishment, grain and fiber dry stalk yield, and other agronomic traits. This is the third year of the study and only 2019 results are presented here.

Materials and Methods

Industrial hemp varieties utilized for this study are listed in Table 1. Seeding dates for the study were May 28, June 10, and June 24 in 2019. The seeding rate was 12 pure live seeds/ft^2 and was adjusted for germination and 1000 KWT with an additional 25 percent added to allow for seedling mortality. Planting depth was one-half inch. Plot size was 25 feet in length x 4 feet in width and consisted of four 12-inch spaced rows. The experimental design was a randomized complete block split-split-plot with four replications. The main plot treatment was seeding date, the subplot was variety and the sub-sub plot was seed treatment. Seed treatments were Metalaxyl (3 fl oz/100 lbs. of seed), Metalaxyl + Ipconazole (1 fl oz/100 lbs. of seed), and the untreated check. The previous crop was barley. Nitrogen fertility additions were based on soil test N to provide 160 lbs/ac N. Phosphorous soil test results indicated 8 ppm with an additional 39 lbs/ac applied. The fiber dry stalk yield harvest date was August 16, 23 for the May 28 and June 4 seeding dates and Sept 6 for the June 24 seeding date.

Data were collected on stand density, pure live seed emergence (PLSE), seedling mortality, test weight, 1000 kernel weight (kwt), seed oil content, grain yield, fiber dry stalk yield and plant height. Stand density was taken by counting plants in two random 3-foot lengths within each plot. Pure live seed emergence, a measure of seedlings that emerge from viable seeds sown, was determined by dividing stand density by targeted seed rate for each plot. Subtracting 100 – PLSE, determined seedling mortality. Seed oil content is reported at 3% moisture. Fiber yield and plant height were only determined on the untreated seed treatment check plots and was analyzed as a split-plot with date as the main

plot and variety as the sub-plot. Fiber harvest consisted of one linear 10-foot row cut from each plot. The plant samples were air-dried and leaves were removed prior to weighing to determine dry stalk yield.

Table 1. Industrial hemp varieties and characteristics for the Langdon 2019 trial.

Variety	Country	Company†	Type	Purpose
Katani	Canada	HGI	Dioecious	Grain
Delores	Canada	PIHG	Monoecious	Dual

†HGI (Hemp Genetics International)
PIHG (Parkland Industrial Hemp Growers)

- Dual purpose varieties are bred to be used for both grain and fiber production and are generally taller.
- Dioecious varieties have separate male and female plants.
- Monoecious varieties have separate male and female flowers on the same plant.
- Plant height is an important consideration in determining end use of the crop. Shorter varieties tend to have less fiber greater harvest ease and are more suited to grain production.

Results and Discussion

The trait sources of variation for the various treatments and their interactions are presented in Table 2.

Weather

Rainfall totaled 17.97 inches during April to September, 3.62 inches above normal, with 10.5 inches of that total received in August and September. Temperatures were 3.3 degrees F. below normal in May, near normal in June and July, 1.4 degree F. below normal in August and 1.2 degrees F. above normal in September for an average of 0.6 degrees F. below normal for the season. A dry period from mid-July to mid-August, coupled with lower than normal subsoil moisture levels, resulted in lower yield for both grain and fiber along with reduced plant heights.

Stand Establishment

No significant differences occurred for stand density, PLSE, and seedling mortality for seeding date, variety, and seed treatment (Table 2). Soil conditions after seeding were nearly ideal yet average PLSE was only 60% for the varieties Katani and Delores averaged over seeding dates and seed treatments (Table 6). PLSE in both 2017 and 2018 seeding date studies averaged 78% across seeding dates, which were more comparable to other crops such as wheat, soybeans and corn. Previous industrial hemp studies were conducted at the Langdon REC in 2015 and 2016. In 2015 soil crusting after planting on June 5, and saturated soil conditions after planting on June 20, 2016 reduced PLSE that ranged from 3 to 9% and 28 to 36%, respectively (Johnson et al., 2016). Continued research is needed to understand why stand establishment is more problematic with hemp than other crops grown in the region.

Grain and Fiber Stalk Yield

Grain yield was significantly higher at the May 28 seeding date compared to the June 10 and June 24 seeding dates when averaged over varieties and seed treatments (Table 3). There was a significant D X V interaction for yield (P=0.041) (Table 5). The variety Delores had a significantly lower yield at the June 24 seeding date compared to Katani. Seed treatments had no effect on grain yield. Yield response trends to seeding

dates were similar to trials conducted in Manitoba, Canada in 2014 and 2015. (Kostuik et al, 2014 and McEachern et al., 2015). Katani grain yield was 10% greater than Delores when averaged across seeding dates and seed treatments (Table 6). No differences were observed in fiber dry stalk yield between seeding dates (Table 3). The taller dual purpose variety, Delores, had greater fiber yields compared to Katani (Table 6).

Test Weight, 1000 KWT, Oil and Plant Height

Seeding date had no effect on 1000 KWT, seed oil percent, or plant height (Table 2). The variety Katani had higher test weight, greater oil percent and lower 1000 KWT compared to Delores. Delores had significantly higher 1000 KWT compared to Katani. The D X V interaction was not considered to be of any agronomic importance.

Table 2. Sources of variation (SOV) and significant F-tests for industrial hemp traits evaluated at Langdon, ND, in 2019.

SOV	Stand Density	PLSE	Mortality	Test Weight	1000 KWT	Oil	Grain Yield	Fiber Dry Stalk Yield	Height
Date (D)	ns	ns	ns	*	ns	ns	*	ns	ns
Variety (V)	ns	ns	ns	*	*	*	*	*	*
D X V	ns	ns	ns	ns	*	ns	*	ns	ns
Seed trt (S)	ns	ns	ns	ns	ns	ns	ns	--	--
D x S	ns	ns	ns	ns	ns	ns	ns	--	--
V x S	ns	ns	ns	ns	ns	ns	ns	--	--
D x V x S	ns	ns	ns	ns	ns	ns	ns	--	--
CV %	15.7	15.7	24.8	1.7	2.8	1.8	8.2	22.3	6.8

*=significant at P≤0.05, ns = not significant.

Table 3. Industrial hemp stand density, pure live seed emergence, seedling mortality, 1000 KWT, plant height, seed oil, test weight, grain yield and fiber dry stalk yield averaged over varieties and seed treatments at Langdon, ND, in 2019.

Seeding Date	Stand Density	PLSE	Seedling Mortality	1000 KWT	Plant Height	Seed Oil	Test Weight	Grain Yield	Fiber Dry Stalk Yield
	Plants/ft^2	%	%	g	In	%	lb/bu	lbs/a	lbs/a
May 28	9.5	59	41	16.1	53	32.4	41.1	1352	2385
June 10	10.1	64	36	16.2	52	32.2	40.1	1230	2276
June 24	9.6	61	39	15.9	51	32.4	39.6	1151	2684
LSD (0.05)	ns	ns	ns	ns	ns	NS	0.7	95	ns

Table 4. Industrial hemp grain yield for three seed treatments averaged over seeding date and varieties at Langdon, ND in 2019.

Seed Treatment	Grain Yield
	lbs/a
Metalaxyl	1243
Metalaxyl + Ipconazole	1240
Check	1250
LSD (0.05)	ns

Table 5. Industrial hemp yield for seeding date and variety averaged over seed treatment at Langdon, ND in 2019.

Seeding Date	Yield (lbs/a)	
	Katani	Delores
May 28	1413	1291
June 10	1217	1245
June 24	1283	1020
LSD(0.05)	Compare varieties at same seeding date = 152	
LSD(0.05)	Compare seeding date for same variety = 143	

Table 6. Industrial hemp variety effect for several factors averaged over seeding date and seed treatment at Langdon, ND in 2019.

Variety	Stand Density	PLSE	Mortality	Test Weight	1000 kwt	Plant Height	Oil	Grain Yield	Fiber Dry Stalk Yield
	Plants/ft^2	%	%	lb/bu	g	in	%	lb/a	lb/a
Katani	9.6	60	40	40.8	14.5	43	32.9	1304	1562
Delores	10.0	61	37	39.7	17.6	60	31.8	1185	3334
LSD (0.05)	ns	ns	ns	0.4	0.3	4.1	0.3	88	503

Conclusions

- Reduced grain yields were observed at later seeding dates.
- Fiber dry stalk yields were not affected by seeding date.
- Seed treatments had no effect on stand density, PLSE, or mortality.

References

Johnson, B.L., B.K. Hanson, M.T. Berti, T. Hakanson, L. Henry, V. Chapara and P.J. Peterson. 2016 Industrial hemp evaluations in North Dakota. *In* Proc. 2016 Meeting ASA, CSSA, SSSA. Nov 6-9 Phoenix, AZ Convention Center. https://scisoc.confex.com/scisoc/2016am/webprogram/Paper102171.html

NDAWN. North Dakota Agricultural Weather Network. https://www.ndawn.ndsu.nodak.edu/

Kostuik, J., S. McEachern and A. Melnychenko. 2014 Manitoba industrial hemp seeding date trial. *In* Parkland Crop Diversification Foundation 2014 Annual Report. P 141-150.

McEachern, S., A. Melnychenko and J. Kostuik. . 2015 Manitoba industrial hemp seeding date trial. *In* Parkland Crop Diversification Foundation 2015 Annual Report. P 161-169.