Seeding Date, Variety, and Seed Treatment Influence on Industrial Hemp Performance in North Dakota-2017
NDSU Langdon Research Extension Center

Bryan K. Hanson[1], Burton L. Johnson[2], Travis W. Hakanson[1], Lawrence E. Henry[1], and Venkat Chapara[1].

[1]North Dakota State University Langdon Research Extension Center, Langdon, ND; [2]North Dakota State University, Plant Sciences, Fargo, ND,

Industrial hemp (*Cannabis sativa* L., THC level of 0.3% or less) can only be grown in North Dakota through the North Dakota Department of Agriculture pilot program or by institutions of higher education as stated in the 2014 farm bill. It has been over 70 years since industrial hemp has been raised in North Dakota. 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 seeding dates, need to be investigated. Pure live seedling emergence (PLSE) of industrial hemp is lower, and often substantially lower, 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 cost effective, common 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.

Materials and Methods

Industrial hemp varieties utilized for this study are listed in Table 1. Seeding dates for the study were May 20, June 1 and June 12. The seeding rate was 12 pure live seeds/ft^2 and was adjusted for germination and 1000 kernel weight (kwt) with an additional 25 percent added to allow for seedling mortality. Planting depth was one-half inch. Plot size was 21 feet long x 4 feet wide and consisted of four 12 inch spaced rows. The experimental design was a randomized complete block split-plot design with four replications. The main treatment plot was seeding date and subplots were a factorial arrangement of variety and 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 soybeans. Total soil nitrogen from the soil test, applied and soybean N credit was equal to 160 lbs/a. Phosphorous soil test results indicated 21ppm. The fiber dry stalk yield harvest dates were August 8, 22, and 31 for the May 20, June 1 and June 12 seeding dates, respectively. Mortality was equal to 100 minus PLSE where PLSE refers to the percent of live seeds that produced a seedling. 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. Fiber yield and plant height were only determined on the untreated check plots. Grain harvest occurred on September 13 for all seeding dates. Industrial hemp is day-length sensitive and flowering occurs at about the same time period every summer regardless of the seeding date. A small plot combine was used to harvest the plots. Samples were dried and then processed to determine grain yield, test weight and 1000 kwt. Plant samples of all varieties, which included leaves and flowering heads, were sent for laboratory analysis of THC. All samples tested less than the 0.3% THC limit for industrial hemp classification.

Table 1. Industrial hemp varieties and characteristics for the Langdon 2017 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 and are more suited to grain production.

Results and Discussion

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

Stand Establishment

Significant differences occurred for stand density, PLSE, and mortality for seeding date and seed treatment. Stand density and PLSE was greater for the May 20 seeding date compared to the June 1 and 12 seeding date. Seedling mortality was higher at the two later seeding dates (Table 3). Pure live seed emergence averaged 78% across seeding dates in 2017. This value is comparable to conventional crops such as wheat, soybeans and corn and is approximately two to three times (or more) greater than previous industrial hemp studies at the Langdon REC in 2015 and 2016. Rainfall of 2.55 inches during the first two weeks of June may have contributed to wet soil conditions that reduced stand density for seeding dates of June 1 and June 12 compared to the May 20 seeding where rainfall was only 0.87 inches from May 1 to May 22 (NDAWN). 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). Stand density was 1.5 plants/ft^2 higher and PLSE 10% greater for the Metalaxyl + Ipconazole seed treatment compared to the check (Table 4). Seedling mortality was lower for the Metalaxyl + Iponazole seed treatment compared to the check while the Metalaxyl treatment was similar to both the Metalaxyl + Ipconaxole and the check treatments.

Grain and Fiber Stalk Yield

Grain yield was 18% lower at the June 12 seeding date compared to the average yield of seeding dates of May 20 and June 1 (Table 3). Yield response to seeding dates was similar in trials conducted in Manitoba, Canada in 2014 and 2015. (Kostuik et al, 2014 and McEachern et al., 2015). Katani and Delores produced nearly identical grain yield when average across seeding dates and seed treatments (Table 5). Although stand density, PLSE, and mortality were significantly affected by seed treatments, there was no effect on grain yield (Table 4). Fiber dry stalk yield was significantly greater at the May 20 and June 1 seeding dates compared to the June 12 seeding date with the taller variety, Delores, having significantly higher yields (Tables 3 and 5).

Test Weight, 1000 KWT, and Plant Height

Variety differences occurred for test weight, 1000 kwt, and plant height, and varied among seeding dates resulting in a variety x seeding date interaction (Table 2). The differences were small and only the main effects of seeding date and variety are reported. The variety Katani had significantly lower 1000 kwt compared to Delores with no differences in 1000 kwt occurring among seeding dates (data not shown). Katani had a higher test weight than Delores while the May 20 and June 1 seeding dates had a significantly higher test weight compared to the June 12 seeding date (Table 4 and 5). Plant height averaged across the three seeding dates for Delores and Katani was 89 and 65 inches, respectively (data not shown).

Table 2. Sources of variation (SOV) and significant F-tests for industrial hemp traits evaluated at Langdon, ND, in 2017.

SOV	Stand density	PLSE	Mortality	Test weight	1000 kwt	Grain yield	Fiber dry stalk yield	Height
Date (D)	*	*	*	*	ns	*	†	ns
Variety (V)	ns	ns	ns	*	*	ns	*	*
D X V	ns	ns	ns	*	*	ns	ns	*
Seed trt (S)	*	*	*	ns	ns	ns	--	--
D x S	ns	ns	ns	ns	ns	ns	--	--
V x S	ns	ns	ns	ns	ns	ns	--	--
D x V x S	ns	ns	ns	ns	ns	ns	--	--
CV %	16.7	16.7	58.4	1.6	3.3	15.0	13.1	3.5

*=significant at P≤0.05; †=significant at P≤0.10; ns = not significant;

Table 3. Industrial hemp stand density, pure live seed emergence, mortality, test weight, grain yield and fiber dry stalk yield for planting dates at Langdon, ND, in 2017.

Seeding Date	Stand density	PLSE	Mortality	Grain yield	Test weight	Fiber dry stalk yield
	Plants/ft^2	%	%	lb/a	lb/bu	lb/a
May 20	13.5	84	16	1875	41.9	5304
June 1	11.9	75	25	1935	41.7	5595
June 12	11.9	75	25	1562	40.7	4542
LSD (0.05)	1.2	6	6	209	0.3	693[1]

[1]LSD (0.10)

Table 4. Industrial hemp stand density, pure live seed emergence, mortality and grain yield for three seed treatments at Langdon at Langdon, ND in 2017.

Seed Treatment	Stand density	PLSE	Mortality	Grain yield
	Plants/ft^2	%	%	lb/a
Metalaxyl	12.3	77	23	1733
Metalaxyl + Ipconazole	13.3	83	17	1873
Check	11.8	73	27	1801
LSD (0.05)	1.2	7	7	ns

Table 5. Industrial hemp variety effect on 1000 kwt, test weight, and grain and fiber dry stalk yield at Langdon, ND in 2017.

Variety	1000 kwt	Test weight	Grain yield	Fiber dry stalk yield
	g	lb/bu	lb/a	lb/a
Katani	15.4	42.0	1783	3021
Delores	19.0	40.9	1799	7271
LSD (0.05)	0.8	0.3	ns	621

Conclusions

- Seeding date influenced stand density, PLSE, mortality, and grain and fiber dry stalk yield.
- The late seeding date resulted in reduced grain yield; however, seed treatment did not affect grain yield.
- Seed treatment with Metalaxyl + Ipconazole improved stand density and PLSE, and reduced mortality, compared with the untreated check.
- Industrial hemp PLSE, mortality and stand establishment are sensitive to soil crusting and wet soil conditions.
- Live seed mortality is often greater for industrial hemp than commonly grown agronomic crops and requires careful grower management regarding planting date, seeding depth, and seed quality.

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.

Acknowledgements
Appreciation is extended to the North Dakota State Board of Agricultural Research and Education (SBARE) New and Emerging Crops committee and North Dakota Agricultural Products Utilization Commission (APUC) for funding support and Hemp Genetics International Inc., Canada and Parkland Industrial Hemp Growers, Canada for providing seed.