

Stand Reduction Effect on Industrial Hemp Yield in North Dakota

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Abstract

As U.S. production of industrial hemp (*Cannabis sativa* L.) increases, defining best management practices and developing risk management policies and guidelines becomes increasingly important for facilitating crop commercialization. The objective of this study was to quantify the effect of stand reduction on industrial hemp seed yield performance for later incorporation into crop hail loss charts. A RCBD split-plot arrangement study was conducted at Langdon and Prosper, ND, during the 2018 growing season. Dioecious, grain cultivar 'Katani' was established at 130 plants/m² where stand reduction treatments (0, 20, 40, 60, and 80%) were applied at three growth stages (GS). Stages of treatment were GS1006, GS1014, and GS2201. Traits evaluated included test weight and seed yield. Test weight was not affected by GS or stand reduction. Mean seed yield, across stand reduction levels, was reduced 6.6 and 8.4% at GS1014 and GS2201, respectively, compared with GS1006. Mean seed yield, across growth stages, was similar for 0, 20, and 40% stand reductions and 10.4 and 13.7% lower for stand reductions 60 and 80%, respectively, compared with the control. The primary yield component for producing high seed yield is establishing and maintaining the proper plant stand throughout the growing season. Industrial hemp has a high compensation capacity to produce more seeds per plant when stand density is reduced for the growth stages evaluated in this study.

The objective of this study was to evaluate stand reduction effects on plant traits seed weight, test weight, and seed yield.

Materials and Methods

- RCBD experiment with four replicates conducted at Langdon, ND (Fig. 1)

- Cultivar – Katina
 - Type – dioecious
 - Purpose – grain
 - Maturity – 105 d

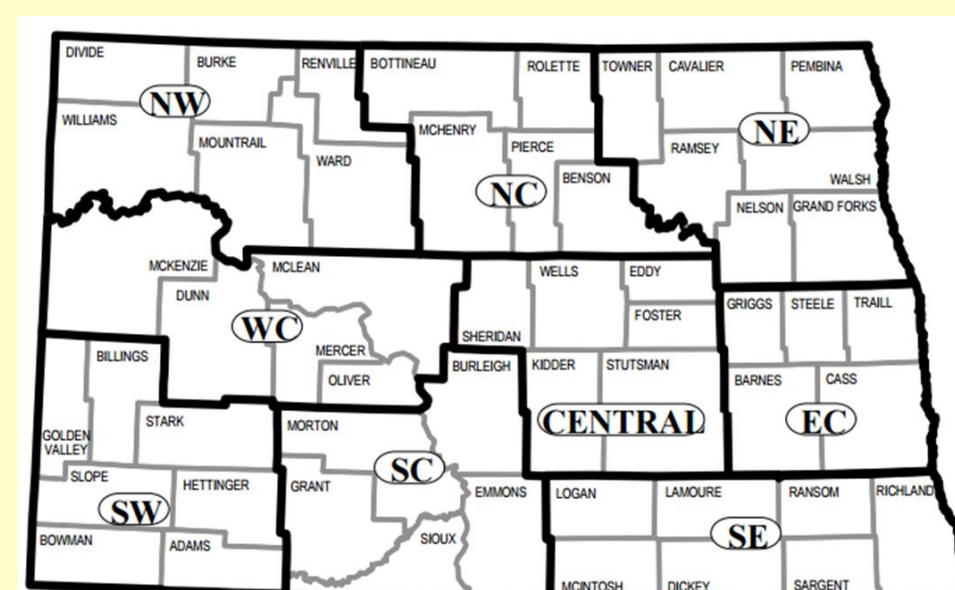


Fig. 1. Langdon, ND, located in Cavalier county at 48.760° N -98.345° W; Elevation: 492 m

- Previous crop – soybean
- Soil pH 6.7
- Soil organic matter 4.8%
- Soil type Svea-Barnes loam

- Seeding date June 4
- Harvest date Sept. 4

- Split-plot design: main plot growth stage; subplot stand reduction
 - Growth stage (Mediavilla et al., 1998)
 - GS 1006 to 1008
 - GS 1014
 - GS 2201 to 2202

- Stand reduction % / plants/m² remaining
 - 0% – 130 plants/m²
 - 20 – 104
 - 40 – 78
 - 60 – 52
 - 80 – 26

- Experimental units (Plots) were four rows, each spaced 30-cm apart and 7.62 m in length (Fig. 2).

- Rainfall – monthly total (NDAWN)
 - April – 7.6 mm May – 43 mm June – 95 mm
 - July – 71 mm Aug. – 32 mm Sept. – 46 mm

- Traits reported
 - Test weight (TW) – kg/hl
 - Seed yield – kg/ha



Fig. 2. Plant density 26 plants/m² (left photo); and 130 plants/m² (right photo); photos taken 21 days after planting

Results

- ANOVA indicated significant growth stage and stand reduction effects for seed yield (Table 1).
- ANOVA indicated nonsignificant growth stage and stand reduction effects for test weight.
- ANOVA did not indicate a significant interaction for GS x SR for either trait.

Table 1. Sources of variation, df, and significant *F*-tests for industrial hemp test weight and seed yield evaluated at Langdon, ND, in 2018.

Sources of variation	df	Test weight	Seed yield
Rep	3	-	-
Growth stage (GS)	2	NS	*
Rep x GS	6	-	-
Stand reduction (SR)	4	NS	*
GS x SR	8	NS	NS
Error	36		
CV%		2.4	9.8

* = significant at $P \leq 0.05$
NS, nonsignificant

- Test weight averaged 49.4 kg/hl which is lower than the 55 kg/hl standard test weight for industrial hemp (Table 2).
- Seed yield was greater at growth stage GS1006 than GS2201.
- Seed yield was similar for growth stages GS1006 and GS2014.
- Seed yield was similar for growth stages GS1014 and GS2201.

Table 2. Industrial hemp stand test weight and seed yield at three growth stages averaged across five stand reduction levels at Langdon, ND, in 2018.

Growth stage	Test weight kg/hl	Seed yield kg/ha
GS1006	49.3	1840
GS1014	49.5	1728
GS2201	49.4	1685
LSD (0.05)	NS	110

- Test weight was not affected by stand reduction and averaged 49.3 kg/hl when averaged across stand reduction levels and growth stages (Table 3).
- Seed yield was similar at 0, 20, and 40% stand reduction levels.
- Seed yield was lower than the control (0%) for the 60 and 80% stand reduction level.

Table 3. Industrial hemp test weight and seed yield at five stand reduction levels averaged across three GSs at Langdon, ND, in 2018.

Stand reduction		Test weight	Seed yield
%	plants/m ²	kg/hl	kg/ha
0	130	49.3	1868
20	104	49.5	1784
40	78	49.6	1814
60	52	49.4	1674
80	26	48.9	1613
LSD (0.05)		NS	142

Discussion

- Test weight was approximately 49.4 kg/hl averaged across treatments and was not affected by growth stage or stand reduction, however this value is lower than the standard 55 kg/hl TW for industrial hemp.
- Lower than optimum TW and seed yield can be associated with plant stress during grain filling that occurred during late July and August.
- Precipitation received at the test site was -12.6, -20.8, -39.9, and -11.9 mm lower than the 30-yr average, during June, July, August, and Sept., respectively.
- Seed yield for the control (0% stand reduction) was 1868 kg/ha and close to Katina's highest yield of 2040 kg/ha at the Langdon REC from 2015 to 2018.
- Yield was reduced 6.6 and 8.4% at GS1014 and GS2201, respectively, compared with the control.
- Yield was reduced 10.4 and 13.7%, respectively, at 60 and 80% stand reduction compared to the control.
- Yield reduction did not become progressively greater as growth stage advanced which has been reported with other crops such as dry bean (*Phaseolus vulgaris* L.), canola (*Brassica napus* L.), and sunflower (*Helianthus annuus* L.) where later stages were more advanced.

Conclusions

- Stand reduction treatments did not affect test weight in this study where stages of treatment occurred at 18, 28, and 36 days after seeding.
- Mean seed yield was reduced at the two later growth stages of treatment compared with GS1006 when averaged across stand reduction levels.
- Mean seed yield was not statistically affected by 20 and 40% stand reduction, but was reduced 10 to 14% at 60 and 80% stand reduction when averaged across growth stages.

References

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- NDAWN. North Dakota Agricultural Weather Network. <https://ndawn.ndsu.nodak.edu/>

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