

Nutrient Use

Nitrogen

Hemp removes or uses a total of 178 actual lbs./A of nitrogen; 35 lbs./A is removed in the seed and 142 lbs./A in the stalk. If the hemp is grown for both grain and fibre production, there will be a large amount of nitrogen removed from the field and growers need to be cognizant of nitrogen requirements for the next production year.

The retting process of the straw allows nutrients like nitrogen and potassium to be leached out and accumulate in the soil under the swaths. Of all the nutrients, phosphorus has the highest percentage stored in the seed. The other nutrients are more inclined to be stored in the stalks.

Depending on the variety, hemp will grow 2.75 to 4 inches a day during its vegetative stage in July to early August. During this development stage, the maximum rate of nitrogen uptake is about 6.0 lbs. N/A/day. Phosphorus uptake is about 1.39 lbs. P₂O₅/A/day.


Nutrient Uptake and Partitioning by Industrial Hemp

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Background


Industrial hemp is grown under license in Canada for seed and/or fibre. Total Canadian production in 2006 was 20,546 ha with 11,721 ha in Manitoba. Little local information exists on the fertility needs of the crop and removal amounts may differ greatly whether grown for seed alone or for fibre. The following study was initiated to track nutrient uptake through a growing season, to observe partitioning within the plant and to establish removal amounts.

Dual purpose hemp is combined with the cutter bar raised to remove the top portion of the plant and leaving much of the stalk. The remaining stalk is swathed and allowed to "ret" or weather on the ground to separate fibres from other stem tissue before baling (see photographs below).



Dry matter (DM) accumulation

Dry Matter Accumulation



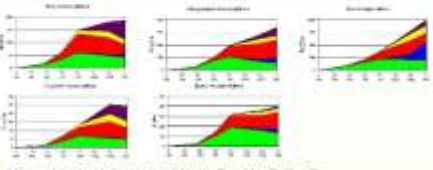
Total biomass exceeded 12000 kg/ha with a grain yield of 1042 kg/ha with a harvest index of 8.6%.

Greatest rate of DM accumulation was in late July at 410 kg/ha/day.

Rate of biomass accumulation slowed in August during flowering, with high temperatures and moisture stress. Some leaf senescence was observed.

Male plants (about 10% of stand) cease growth and senesce after flowering.

Micronutrient uptake



Micronutrient uptake was small with Fe > Mn > B > Zn > Cu.

Iron (Fe) appeared to increase through grain fill but is likely a result of soil contamination on fallen leaves.

Zn and Cu appeared to translocate from vegetative tissue and accumulate in the seed, whereas Mn, Fe and B remained in vegetative tissue.

Method

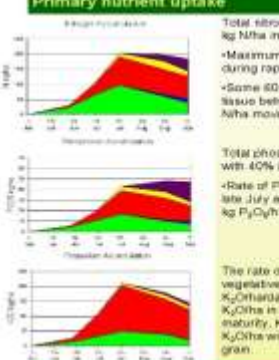
A commercial 85 ha hemp field in northwestern Manitoba near Dauphin was selected for the study. The soil was a moderately well drained Gilbert sandy loam. The field had previously been cropped to oats and alfalfa hay.

The cultivar USD 31 was seeded on May 12, 2007 at 39 kg/ha with a zero-till air seeder in 25 cm wide rows with a 7.5 cm wide seed spread. The previous fall 150 kg K₂O/ha was broadcast followed by 60 kg N, 37 kg P₂O₅ and 11 kg S/ha in a mid-row band at seeding.

Plants were sampled from a 3 m row length on a 2-week schedule (see figure below) in a RCBD sampling pattern with 2 replicates. Above-ground parts were sampled, partitioned, dried, chopped and ground for nutrient analysis by ALS Labs. Flower material was considered the reproductive portion of the head and the chaff after threshing the seed. The August 9 sampling had excessive leaf loss in handling and data is not shown here. Fallen leaves were captured for later sampling dates.

Primary nutrient uptake

Total nitrogen (N) uptake was 200 kg/ha with 40 kg N/ha in the grain.



- Maximum rate of N uptake was 6.7 kg N/ha/day during rapid vegetative growth in late July.
- Some 60 kg N/ha disappeared from vegetative tissue between flowering and maturity with 40 kg N/ha moving into the seed.

Total phosphorus (P) uptake was 47 kg P₂O₅/ha with 40% in the grain.

- Rate of P uptake was 1.36 kg P₂O₅/ha/day in late July and later accumulated in grain at 0.61 kg P₂O₅/ha/day.

The rate of potassium (K) uptake during vegetative growth in July was 6.0 kg K₂O/ha/day. The greatest K uptake was 211 kg K₂O/ha in late July at the start of flowering. By maturity, K content had declined by 66 kg K₂O/ha with only 10 kg K₂O/ha removed in the grain.

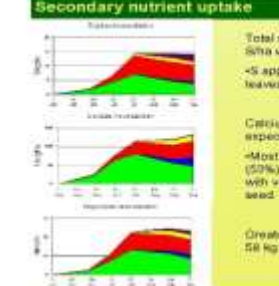
Influence of retting on nutrient removal

For fibre harvest, the stalks are swathed and left in the fields to "ret" or for fibres to loosen. During this weathering process nutrients may be leached from the stalk into the soil. The following table shows the yield and nutrient content of hemp stalks sampled from this field. It is apparent that despite high uptake of potassium, very little is actually removed when hemp is allowed to ret in the field.

Stalk sample	Stalk yield (kg/ha)	Nitrogen	Phosphorus	Potassium	Sulphur
Content % (kg/ha)					
September 7 standing	8884	0.07 % N	0.07 % P	0.87 % K	0.07 % S
October 16 standing	4501	0.02 % N	0.05 % P	0.54 % K	0.07 % S
October 16 Retted	4501	0.72 % N	0.06 % P	0.11 % K	0.06 % S

Secondary nutrient uptake

Total sulphur (S) uptake was 14 kg S/ha with 20% in the grain.



- S appeared to be translocated from leaves to the grain.

Calcium (Ca) uptake was greater than expected.

- Most Ca was present in leaves (50%), stem (33%) and flower (12%) with very little accumulation in the seed.

Greatest magnesium (Mg) uptake was 58 kg Mg/ha with 8% in the grain.

Discussion

The magnitude of nutrient uptake was similar to that observed in earlier Manitoba studies (1). The rapid hemp growth that occurred in July caused most nutrients to be taken up at high rates. Nutrient accumulation slowed after this period for a number of possible reasons.

- Male plants comprise about 10% of the population and they cease growth and senesce after pollination.
- Several days exceeding 30°C and low soil moisture occurred in early August leading to some lower soil moisture. Not all senescing leaves may have been captured during our sampling.
- Stalk growth generally slows during flowering but resumes during seed development.

Although the hemp crop takes up a considerable quantity of nutrients, most remain in the stalk going to the low harvest index and a low amount is removed in grain (the exception being P). With the retting process in the field, the majority of the potassium leaves up and accumulated in the stalk appears to be leached out. This does have some agronomic implications as potassium is concentrated under swaths.

References

1. Heard, J. 2001. Industrial hemp seed fertility. Summary of Manitoba studies. In Proceedings of 44th Annual Manitoba Soil Science Society Meetings, Winnipeg, 2001, pp. 183-185.

Acknowledgements

Covering time (2003) - Patience Corp. Diversification Foundation
 ALS Laboratory Group

Combine harvest of the entire field on September 19 averaged 1067 kg/ha of clean seed

Hemp seed, as with other crops, will be sensitive to seed-placed nitrogen fertilizer. It is recommended that nitrogen be broadcast, side-banded, mid-row-banded or banded in a separate operation.

Phosphate

Hemp is a high user of phosphate and it is essential to have phosphate in an available form early in crop establishment and during the growing season. Phosphate is immobile in the soil so close association to hemp roots is essential. Phosphate management trials in the past have shown that hemp does have some tolerance to seed placed P_2O_5 . Soil type, soil moisture and seed opener spread all have an effect on seed placed phosphate, so caution should be used to find a rate that is suitable with your conditions and equipment.

Some limited research has been conducted on phosphate fertility in hemp (PCDF). Two years of trials indicate a reasonable tolerance to seed placed phosphate. Under ideal growing conditions, plant population and grain yield was not affected by increasing the rates of P_2O_5 up to 50 pounds actual per acre. At the suggested rate of 31 to 40 pounds/acre and good growing conditions, damage is not expected to hemp seedlings in a clay loam soil with an offset disc opener.

Seed placed phosphate can cause loss of germination if there is less than ideal conditions such as cool soils, dry or wet compacted soils. Seed placed fertilizer could cause extra stress on the young plants and increase the plant mortality under diverse conditions. More research is required to understand phosphate placement and hemp production.

Micronutrients

Micronutrients are nutrients required in extremely small quantities (less than 100 ppm in plant dry weight). The basic functions of micronutrients are less understood than macronutrients. Micronutrient deficiencies in hemp are less common than macronutrient deficiencies and part of this may be due to the lack of documentation and reporting. More research and documentation of micronutrient identification, deficiencies and yield effects is required.

Application Rates

General rates for the total amount of each nutrient to target in dryland production (actual):

- Nitrogen 80 to 120 lbs.A
- Phosphorus 40 lbs.A
- Potassium 54 lbs.A
- Sulfur 13 lbs.A

*These rates include soil supplied nutrients plus applied.

Factors that affect nutrient uptake and removal include:

- environmental and growing conditions
- seeding date
- soil pH and salinity
- excess soil moisture and soil compaction restricting the aerobic ability of the soil
- varietal differences

Nutrient Uptake and Removal of Field Crops lbs.A					
	Total Plant lbs.A		Grain lbs.A		Uptake
Nutrient	Hemp*	Canola**	Hemp*	Canola*	Hemp/day**
N	178	107	35	58	6
P	42	45	17	31	1.39
K	188	67	9	15	5.35
S	13	18	2.7	11	
*Source Canola: Canadian Fertilizer Institute					
**Source Hemp: MAFRD					