Biomass and Nutrient Accumulation in Hybrid Canola

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Abstract

Measuring and characterizing aboveground biomass and nutrient accumulation may help us understand the fertility requirements of hybrid canola and lead to better fertilization programs for this crop. The original objective was to measure Nitrogen use by hybrid canola; appropriate timing of N application, if a window of opportunity does exist in season, will reduce N rate and NO_3-N remaining at the end of the season. This was extended to all nutrients. A study was initiated in 2003 that included experiments out at four sites (two in Manitoba and two in Alberta) using one cultivar (45H21). The basic design was a control, two N rates, 54 and 90 lb N/acre (60 and 100 kg N ha^{-1}), and 54 lb N/acre plus topdressing of 36 lb N/acre (40 kg N ha^{-1}) at 3, 4, 5, 6 and 7 weeks after seeding. We carried out weekly sampling of canola and determined biomass, and N, P, K, S, Ca, Mg, B, Cu, Fe, Mn and Zn concentration. Peak of N, P and S uptake, as an example, was at the 6-leaf growth stage of canola. Only the N data are presented here. We used topdressing of N at 3, 4, 5, 6, and 7 weeks after seeding as an alternative practice. Its success was directly related to timing of precipitation.

Introduction

Topdressing N fertilizer on canola during the growing season offers potential benefits in cost (prices normally drop after the seeding season) and efficiency (applying N at the time of highest demand by the plant may reduce fertilizer losses). Appropriate timing of N application, if a window of opportunity does exist in season, will reduce N rate and NO_3-N remaining at the end of the season. Endres et al. (2002) compared application of all fertilizer N pre-plant to applying some or all the N post-emergence as urea. At one location in 2001, a significant yield increase was observed with topdressing N at either the 5-leaf or the early bud stage. However, in another four sites, topdressing had a minimal effect on yield. Johnston and Lafond (2003) reported that there was an absolute requirement of post-application precipitation in order to move the fertilizer into the soil, if N topdressing was to be effective.

The objectives of this study were to measure Nitrogen (and other nutrient) use by hybrid canola and ascertain whether topdressing canola with N is feasible and, if so, identify the appropriate growth stage(s) suitable for this purpose.

Materials And Methods

Four trials were established in 2003 at two locations in Alberta and two in Manitoba (Table 1). Both Manitoba sites were sown on May 7, whereas the Carstairs and Olds sites were sown on May 19 and 20, respectively. All sites were seeded to a glyphosate tolerant cultivar (45H21), the

Manitoba sites with a six-row hoe drill at 22.5-cm spacing (9 inch) and the Alberta sites with an airseeder with 22.9 cm spacing and equipped with 1.9-cm (3/4 inch) knives at a rate of 162 and 159 seed m^{-2}, respectively.

Table 1. Site characteristics of the four trials.

	Organic matter (%)	Texture	pH	EC	NO_3-N	P	K	SO_4-S
						lb/acre		
Carstairs	7.3	Loam	6.5	0.2	26	67.8	784	24
Olds	5.4	Loam	6.9	0.1	28	36.8	510	30
Rosser	7.5		7.2	0.78	43	38	1040	28
Petersfield	7.4		7.3	0.74	69	86	900	38

The experimental design included a control and seven fertilization treatments as follows: 54 lb N/acre (60 kg N ha^{-1}) at seeding, 90 lb N acre (100 kg N ha^{-1}) at seeding and split application of 90 lb N/acre with 54 lb N/acre applied at seeding time and 36 lb N/acre (40 kg N ha^{-1}) topdressed in ammonium nitrate (34.5-0-0) form at either 3, 4, 5, 6, or 7 weeks after seeding. Nitrogen treatments at seeding time were side banded. All trials received a blanket application of seed-placed P_2O_5 as triple super phosphate (0-45-0) at a rate of 22 lb/acre (25 kg ha^{-1}), and K_2O and S as potassium sulphate (0-0-51-17) at a rate of 46 and 15 lb/acre (51 and 17 kg ha^{-1}), respectively. All treatments were replicated six times, except for the 90 lb N/acre treatment that was replicated seven times; six of the replicates of the latter treatment were utilized for final harvest at maturity and the seventh replicate was used for obtaining canola biomass samples on a weekly basis. Samples from a 0.5 m X 0.5 m area were dried, weighed and were assayed for N, P, K, S, Ca, Mg, B, Cu, Fe, Mn and Zn concentration.

A tipping bucket rain gauge was installed at each of the four sites to record precipitation events during the growing season. Available soil moisture content was estimated at seeding and again at harvest time using a soil moisture probe and converting depth of moist soil to inches of available moisture based on soil texture.

The results from all tests were subject to ANOVA and regression analysis using SYSTAT 8.0 (SPSS Inc. 1998).

Results And Discussion

Although biomass from canola was assayed for all nutrients, only the results relating to N are presented here.

Empirical soil moisture estimates at seeding time suggested that the soil profile of all sites was fully charged with water. Precipitation varied with site, however, three different trends emerged: the two Alberta sites received most of the growing season precipitation by July 11 and remained dry for the balance of the season; the Rosser site received no rain until July 3 but no appreciable amounts after that, whereas the Petersfield site received precipitation on a number of occasions during the growing season (Figure 1).

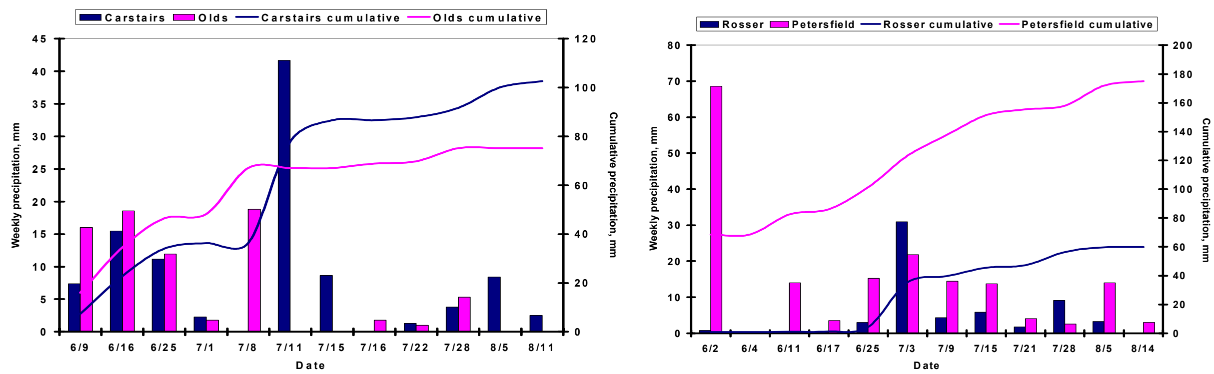

Figure 1. Precipitation received at the four sites during the growing season.

Biomass Accumulation and Seed Production

Biomass accumulation at the four sites generally followed an initial slow growth phase, then a stage of accelerated growth and, finally, no further growth during senescence; a notable exception was the canola growth at the Peresfield site, where growth continued until harvest, albeit at a much reduced rate (Figure 2).

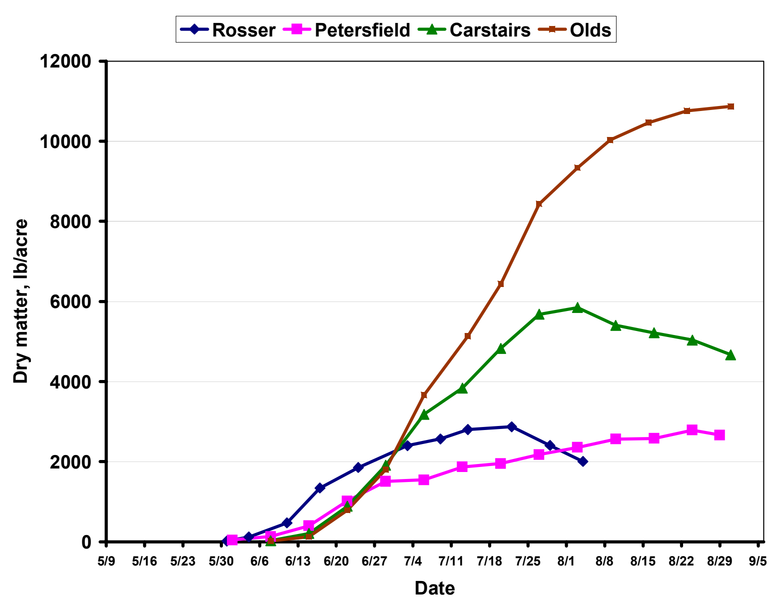

Figure 2. Canola biomass accumulation at the four sites.

The rate of daily biomass accumulation ranged from 88-97 lb/acre/day (98-108 kg ha^{-1} d^{-1}) at Petersfield and Rosser to 182-266 lb/acre/day (204-298 kg ha^{-1} d^{-1}) at Carstairs and Olds (Figure 3). Total moisture use (MU) at the four sites ranged from 212 to 324 mm (8.35 to 12.8 inches) (Table 2). Growing season precipitation accounted for less than 50% of MU at three of the four sites, thus resulting for the most part in reliance of the 2003 canola crop on soil store moisture.

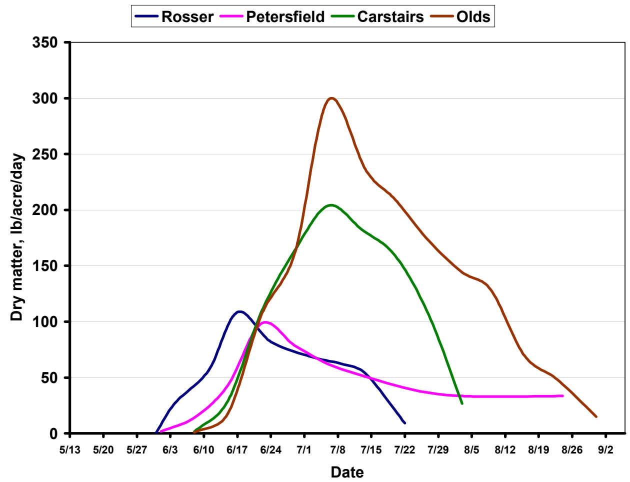

Figure 3. Canola rate of biomass accumulation at the four sites.

Table 2. Moisture use of 45H21 canola at the four sites.

	Rosser	Petersfield	Carstairs	Olds
Moisture Use, mm	212	324	253	253
Moisture Use, in.	8.35	12.8	9.95	9.95
Growing season precipitation, mm	60	172	100	75
Growing season precipitation, in	2.35	6.8	3.9	3
Growing season precipitation, % total	28	53	39	30

Biomass production per unit moisture (moisture use efficiency, MUE) was similar in the two Manitoba sites but was considerably higher at the two Alberta sites (Table 3). MUE at Olds was in the order of almost 10X that of the two Manitoba sites and 6X of that at Carstairs pointing out to the extremely unusual conditions at this site. However, in spite of the extreme differences in MUE for biomass production, MUE for seed production was much less variable (Table 4), which reflects the much higher production of vegetative parts at the two Alberta sites (Figure 2) and the resulting lower harvest index due to the extremely dry conditions during seed formation.

Table 3. Biomass production of 45H21 canola.

	Rosser	Petersfield	Carstairs	Olds
	At peak production			
Biomass, kg ha^{-1}	3212	2870	6549	12173
MUE total, kg mm^{-1}	16.1	16.7	25.9	157.1
MUE precipitation, kg mm^{-1}	68	8.8	65	53
	At maturity			
Biomass, kg ha^{-1}	2244	2870	5227	12173
MUE total, kg mm^{-1}	10.6	16.7	21.6	157.1
MUE precipitation, kg mm^{-1}	38	8.8	52	53

Table 4. Seed production and moisture use efficiency of 45H21 canola at the four sites.

	Rosser	Petersfield	Carstairs	Olds
Grain yield, kg ha^{-1}	1769	3013	2285	2559
Grain yield, bu/acre	31.6	53.8	40.8	45.7
MUE total, kg mm^{-1}	8.3	9	9	10.1
MUE bu/inch	3.8	4	4.1	4.6

Nitrogen Accumulation

Nitrogen accumulation during the growing season peaked at the 6-leaf stage independently of seeding date and environmental conditions (Figure 4). The maximum daily accumulation rate was 5.8 lb/acre/day (6.5 kg ha^{-1} d^{-1}) at Carstairs and Petersfield, which were associated with higher precipitation and moisture use from growing season precipitation of 39 % or more, and 7.1-7.6 lb/acre/day (8-8.5 kg ha^{-1} d^{-1}) at Olds and Rosser, which were associated with lower precipitation and moisture use from growing season precipitation of 30 % or less. In spite of these differences, N removal by canola seed was identical (2.1 lb N/bu) in all four experiments (Table 5).

Table 5. Nitrogen removal in the seed and vegetative parts of 45H21 canola at the four sites.

	Rosser	Petersfield	Carstairs	Olds
lb N/bushel at peak	2.9	5.1	3.1	1.4
lb N/bushel at maturity	3.3	3.3	3.4	2.9
lb N/bushel grain	2.1	2.1	2.1	2.1
lb N/bushel vegetative parts	1.2	1.3	1.3	0.8

The results of this study would suggest that topdressing of N should be carried out just prior to or at the 6-leaf stage of 45H21 canola. This hypothesis was tested with the topdressing experiments that were carried at these four sites. Topdressing of N was effective only at the Petersfield site that received considerable amounts of precipitation during the period of topdressing (Figure 5). Maximum yield with topdressing was statistically significant only at 5 and 6 weeks after seeding that correspond closely to the 6 leaf growing stage of canola and was 5 bu/acre greater than the treatment that received 90 lb N/acre at seeding.

Conclusions

Measuring and characterizing aboveground biomass and nutrient accumulation is helping us understand the fertility requirements of hybrid canola and, hopefully, will lead to better fertilization programs for this crop. Splitting N applications could be an advantage if it remains dry and there is no need for additional N, however, it could prove to be uneconomical because of the extra cost for the topdressing application and damage to the standing crop. Further, it may lead, as was the case in 2003, to a missed opportunity on well-charged soils. Therefore, based on the first year of this study it is considered a “high risk” practice.

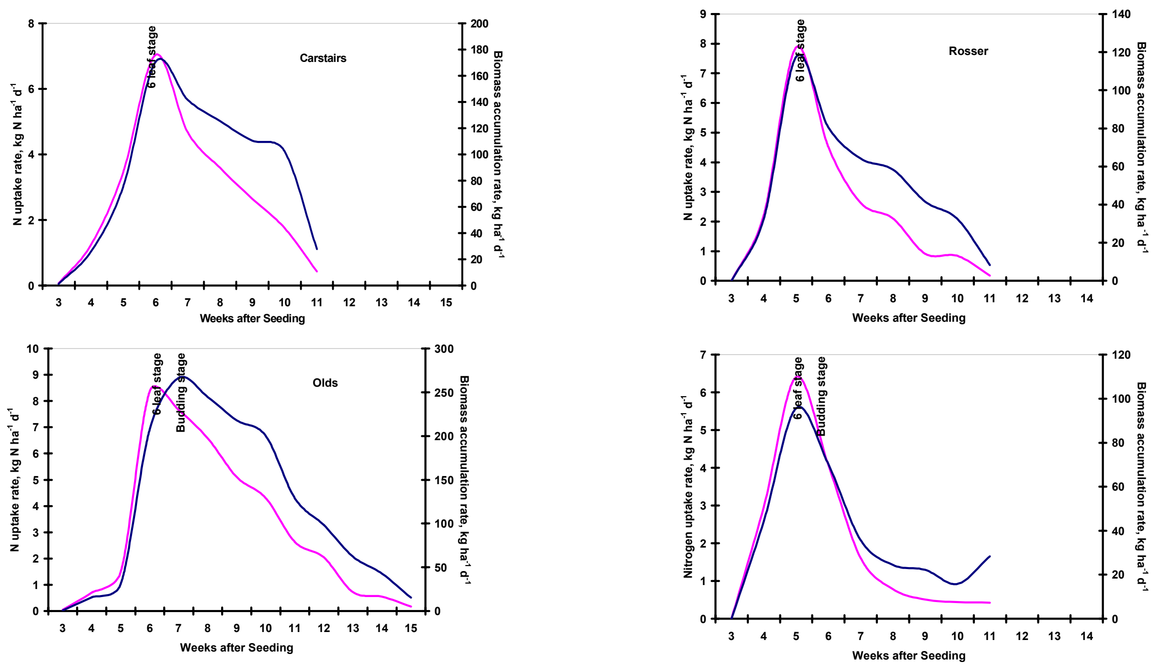

Figure 4. Daily rate of N uptake bu 45H21 canola at the four sites.

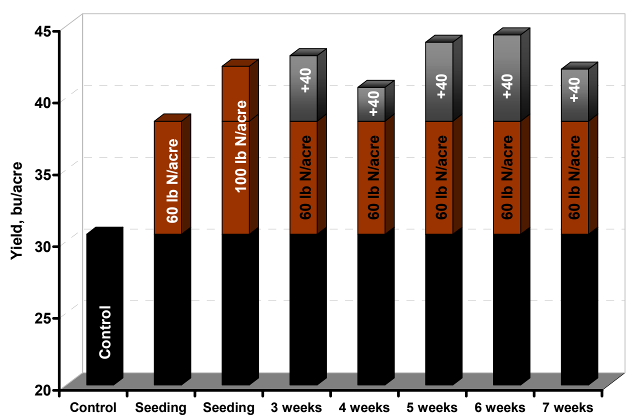

Figure 5. Response of 45H21 canola to topdressed N at Petersfield.

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