Re-evaluation of the optimum nitrogen rates for processing tomato production

University of Guelph, Ridgetown Campus
John Zandstra (PI) and Harpreet Hanzra (Vegetable Research Technician)

Objectives: re-evaluate nitrogen rates on newer and existing processing tomato cultivars on 2 soil types.

Methodology: Two similar experiments were established at Ridgetown Campus Research Farm in 2023 on two different soil types; a sandy loam (65.7% sand, 5.6% silt, 28.7% clay) and clay loam (32.0 % sand, 31.0%silt, and 37.0% clay). The three cultivars were used in this trial - C339, H1014, and H3406. On these cultivars, 6 nitrogen rates were superimposed - 0, 50, 100, 150, 200, and 250 kg actual N per acre. Nitrogen was applied in the form of urea and fertilizer treatments were applied by hand. Additional P and K were applied when required based on soil nutrient analysis. Tomato transplants were sourced from local transplant growers. Each plot consisted of one twin-row bed, 8 m long by 1.5 m wide with a "2 buffer" bed between each N treatment. Transplanting was completed using a commercial twin row RJ transplanter with a row spacing of 45cm and an in-row spacing of 45 cm. On the clay loam site, transplanting was completed on May 19, 2023, whereas on the sandy loam site, transplanting occured on May 26, 2023. A pre-emergence herbicide tank mix of Dual Magnum & Sencore at the recommended rates was applied to control weeds. Broad spectrum fungicides (Bravo and Zampro) were continuously applied at 10 -12-day intervals starting from June 29, 2023, until 3 weeks before harvest. After transplanting, a plant survival count was taken, and 8 weeks after transplanting, 3 plants per plot were used to collect plant dry weight. Plots were harvested (6 plants per plot) when 80% of the fruit across all the cultivars appeared red; Ethrel was not used. Increasing nitrogen rates reduced plant stand so care was taken to harvest from an area that had a complete complement of plants. Fruit was graded into red, green, breaker, and rot and expressed as tons/acre as well as % red fruit. The experimental design was as a strip plot with two main factors consisting of cultivar (vertical strip) and nitrogen rate (horizontal strips) treatments.

Results and Discussion: There was a significant effect of nitrogen treatment on the percent survival of tomato transplants in both the sandy loam and clay loam sites. The highest survival (89.60 % in clay loam and 91.70% in sandy loam) was found in the control treatment across all cultivars. The lowest transplant survival (62.7 % in clay loam and 78.6% in sandy loam) was found in the 250 kg ha^{-1} nitrogen treatment across all cultivars (Tables 1 and 2). Poor survival of tomato transplants in high nitrogen treatments might be due to the 'salt effect', in which higher concentrations of salts in fertilizers causes higher osmotic pressure in the soil and result in the movement of the water out of the plant, causing the death of the plant.

Dry matter accumulation 8 weeks after transplanting did not differ in response to nitrogen rate when averaged across cultivars. However, the dry matter accumulation of cultivar differed when averaged across nitrogen rates; this significant in both sandy and clay loam soil types (Tables 1 and 2). In both soil types, maximum dry matter accumulation was recorded in the H1014 cultivar treatment, and

the lowest was in C337 (Tables 1 and 2). The difference in dry matter accumulation might be due to the different growth characteristics of the cultivar.

No significant differences were noted in the percentage of red fruit when averaged across cultivars indicating the plots were harvested at relatively the same maturity. There were no significant interactions between cultivar and N fertilizer rate in any variables evaluated on the clay loam site; red and total fruit yields increased as the N rate increased (Table 2) except for a drop in yield at the 150 kg N ha^{-1} rate; the reason for this is unknown. A significant interaction between cultivar and N rate was found on the sandy loam site; on this site red and total yields were higher at the 0 kg N ha^{-1} rate when compared to the clay site, but tended to be lower at the highest N rate. Yield response to N rate on the sandy loam site tended to be more variable overall (Table 3).

On the clay site the highest red and total fruit yields were found at the highest N rate and yields tended to increase as the N rates increased; on the sandy loam site, 0 kg N ha^{-1} produced yields almost 2.5 times greater than the same rate on the clay site, suggesting significant N reserves in this soil type. Yield responses on the sandy loam site were more erratic in response to N rate than on the clay site.

In 2024 we need to use split N applications on the higher N rates to avoid plant mortality that was seen in 2023; we anticipate this is needed at rates of 150 kg N ha^{-1} and higher and will confirm this after grower consultations. We also decided not to use Ethrel in 2023 as we wanted an indication of the delay in maturity caused by the N treatments; we will also need to consult with the research committee to see if this is acceptable.

Table 1: Effect of tomato cultivars and nitrogen rates (kg ha^{-1}) on survival count and tomato crop yield (tons ha^{-1}) in clay loam soil texture during 2023 at University of Guelph, Ridgetown, Ontario.

Treatment	Survival	Dry wt.	Yield (tons ha^{-1})				Percent of red tomato
Cultivars (C)	%	(g)	Red	Green	Breaker	Total	
C 337	78.5	58.9 b	116.2 b	12.1	7.1	135.3	86.0 ab
H 1014	81.3	86.4 a	142.5 a	8.97	5.9	157.4	90.4 a
H 3406	79.5	82.0 a	112.1 b	13.8	11.0	137.0	81.9 b
[z]SE	**1.91**	**4.54**	**5.78**	**1.28**	**1.02**	**7.22**	**1.15**
Nitrogen (kg N ha^{-1})							
0	89.60 a	57.6	58.4 d	6.4 b	5.2 b	70.0 d	82.4
50	91.38 a	86.4	91.9 cd	6.9 b	4.3 b	103.1 cd	88.8
100	85.72 ab	93.6	128.6 bc	14.6 ab	10.3 ab	153.6 bc	83.7
150	77.07 abc	69.5	124.4 bc	8.5 b	6.3 ab	139.3 bc	89.5
200	72.03 bc	61.1	144.8 b	12.1 ab	8.8 ab	165.7 b	86.9
250	62.7 c	87.5	193.5 a	21.2 a	16.8 a	227.8 a	85.4
SE	**3.58**	**13.3**	**10.03**	**2.29**	**2.33**	**12.36**	**2.02**
Effects	----------*P values*----------						
C	NS	0.0070	0.0130	0.0790	0.0299	NS	0.0077
N	0.0004	NS	<0.0001	0.0052	0.05	<0.0001	NS
C x N	NS	NS	NS	NS	NS	NS	NS

[z]SE indicates standard error of means.

[a-d]In each column and for each effect, means followed by a different letter indicate statistically significant effect at $P<0.05$ per Tukey-Kramer adjustment.

Note: Six plants per plot crop were harvested on different dates in September based on >80% visually red tomato, and the experimental design was strip plot design. Treatment 0 (kg N ha^{-1}) harvested on Sept 6, 50 (kg N ha^{-1}) harvested on Sep 11, treatment 100 (kg N ha^{-1}) was harvested on Sept 12, treatment 150 (kg N ha^{-1}) was harvested on Sept 18, treatment 200 (kg N ha^{-1}) was harvested on Sept 18, and treatment 250 (kg N ha^{-1}) was harvested on Sept 2023.

Table 2: Effect of tomato cultivars and nitrogen rates (kg ha^{-1}) on survival count and tomato crop yield (tons ha^{-1}) in sandy loam soil texture during 2023 at University of Guelph, Ridgetown, Ontario.

Treatment	Survival	Dry wt.	Yield (tons ha^{-1})				Percent of red tomato
Cultivars (C)	%	(g)	Red	Green	Breaker	Total	
C 337	82.6	61.9 b	142.9 b	8.58 b	6.21 b	162.0 b	88.4 a
H 1014	86.3	98.3 a	160.4 ab	4.53 b	4.07 b	177.8 b	90.4 a
H 3406	87.5	75.3 b	166.28 a	19.48 a	17.12 a	212.0 a	79.9 b
[z]SE	**1.30**	**4.50**	**4.21**	**2.26**	**1.08**	**4.38**	**1.54**
Nitrogen (kg N ha^{-1})							
0	91.7 a	85.5	132.8 b	7.49	5.5	145.7 b	92.1
50	89.3 ab	75.6	155.6 ab	13.58	11.2	180.5 ab	86.2
100	85.1 abc	82.6	168.3 a	11.40	9.5	201.6 a	83.8
150	87.2 ab	73.6	147.0 ab	11.23	9.5	174.0 ab	85.2
200	81.0 bc	79.0	162.1 ab	11.07	10.9	204.8 a	81.7
250	78.6 c	74.8	173.5 a	10.40	8.3	197.0 a	88.6
SE	**1.81**	**5.88**	**6.24**	**3.40**	**2.56**	**8.85**	**2.14**
Effects	----------*P values*----------						
C	NS	0.0057	0.0338	0.0016	<0.0001	0.0006	0.0082
N	0.0013	NS	0.0068	NS	NS	0.0039	NS
C x N	NS	NS	0.0401	NS	NS	NS	NS

[z]SE indicates standard error of means.

[a-d]In each column and for each effect, means followed by a different letter indicate statistically significant effect at $P<0.05$ per Tukey-Kramer adjustment.

Note: Six plants per plot crop were harvested on different dates in September based on >80% visually red tomato, and the experimental design was strip plot design. Treatment 0 (kg N ha^{-1}) and 50 (kg N ha^{-1}) harvested on Sep 13, treatment 100 (kg N ha^{-1}) was harvested on Sept 25, treatment 150 (kg N ha^{-1}) was harvested on Sept 26, treatment 200 (kg N ha^{-1}) was harvested on Sept 27, and treatment 250 (kg N ha^{-1}) was harvested on Sept 29.

Table 3. Interaction between cultivars and N rate treatments on the red tomato yield (kg ha^{-1}) at the experiment conducted in the sandy loam soil texture at Ridgetown, Ontario.

	Cultivars			
N treatments (kg N ha^{-1})	C337	H1014	H3407	Means across cultivars
0	129.65 b	140.58 ab	128.13 b	132.8 b
50	142.32 ab	182.77 ab	141.78 ab	155.6 ab
100	163.55 ab	159.58 ab	181.65 ab	168.3 a
150	128.88 b	143.68 ab	168.45 ab	147.0 ab
200	143.98 ab	160.32 ab	181.90 ab	162.1 ab
250	149.22 ab	175.45 ab	195.77 a	173.5 a
Means across N treatments	142.9 B	160.4 AB	166.28 A	

Within each column, means followed by a different lowercase letter indicate statistically significant effect at $P<0.05$ per Tukey-Kramer adjustment.

In each row, treatment means followed by a different uppercase letter indicate statistically significant effect at $P<0.05$ per Tukey-Kramer adjustment.