Simulated hail timing and severity on sugarbeet root yield and sucrose content

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NDSU EXTENSION

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Abiotic affects damaging sugarbeet in North Dakota and Minnesota

- Frost
- Excessive rainfall
- Insufficient water
- Hail
- Wind

But hail is probably the most hideous of them all


Norman County, June 28, 2024

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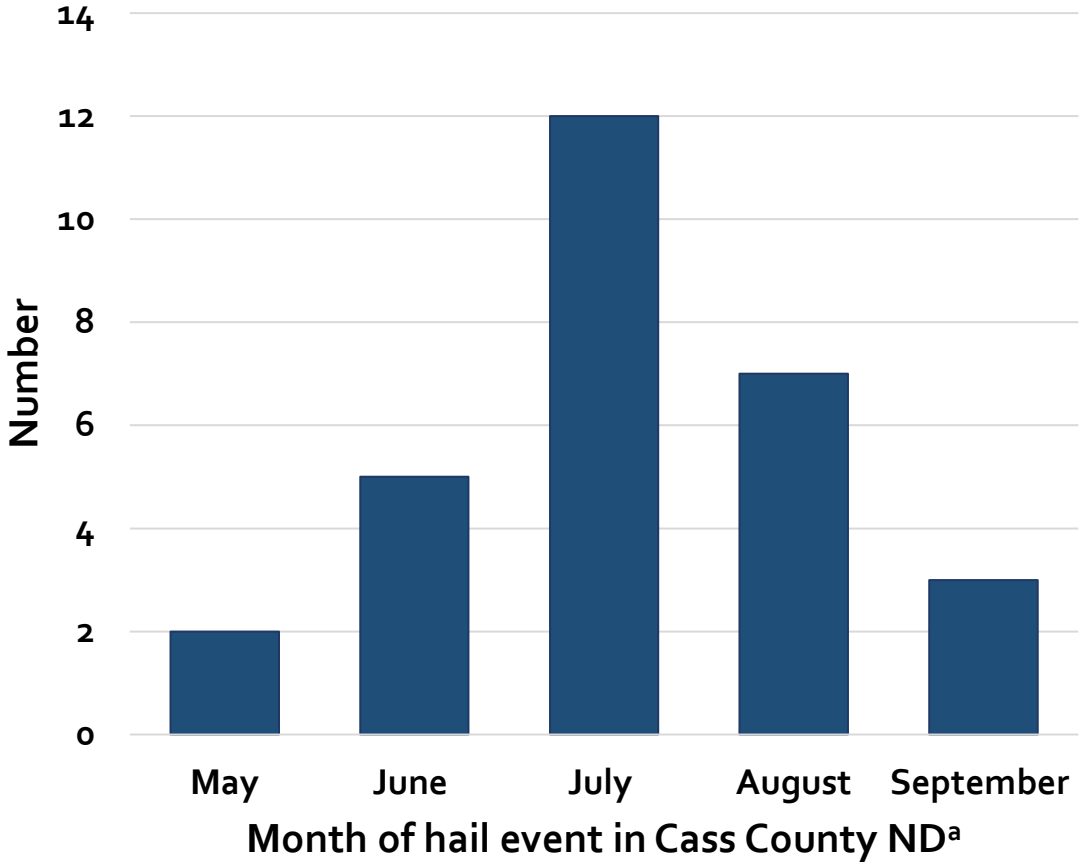
South of Sabin, MN on Clay County Rd 11, July 9, 2023

Perley, MN, July 11, 2016

Root yield losses and sucrose reduction depends on the plant growth stage when plants are injured and the degree of defoliation

- Defoliation early in season (May and early June) or in mid- to late-September caused nominal yield reduction (Carter et al. 1977).
- 100% defoliation 'mid-season' (July) reduced yield by 25% to 30% (Morris 1950, Afanasiev et al. (1960).
- Negligible effect on sucrose content from 25%, 50% or 75% damage treatments (Soine 1966).
- 100% defoliation reduced sucrose content 12 to 14% from simulated hail on June 30 or on August 31.



[a]https://www.stormersite.com/hail_reports/fargo_north_dakota/all, 2004 to 2023

Outbreak of rhizomania partially explains the switch from triploid to diploid genetics

Triploid- larger canopy

Diploid- smaller canopy

Image courtesy of Mark Anfinrud, SES Vanderhave

There is subtle variation in diploid genetics

Upright leaf architecture **Wider and more prostrate leaf**

Image courtesy of Mark Anfinrud, SES Vanderhave

Objective: Determine root yield and % sucrose loss from simulated sugarbeet defoliation at different levels of intensity and timing

Much of the research in sugarbeet to investigate loss of root yield and reduction of sucrose was conducted in the 1950s and 1960s

- Changes in genetics
- Row spacing
- Population density

Defoliation Technique

Considered many including:

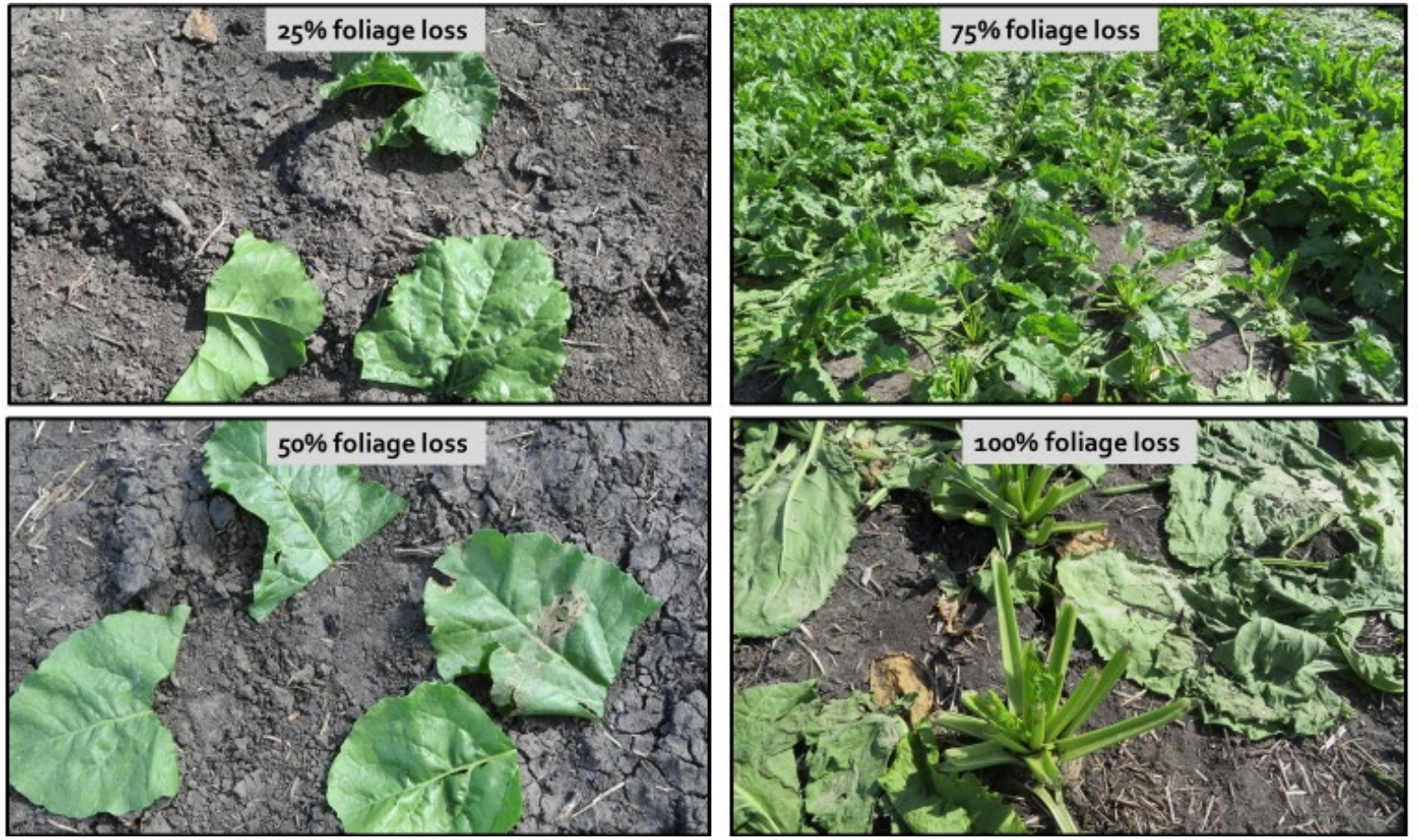
- String weed trimer
- Hand desiccation
- Rotary hoe
- Defoliator

Decided to use scissors and shears

- Remove leaves
- Remove percent of leaves

Materials and Methods

- Locations: Ada, MN, Crookston, MN and Hendrum, MN
- Years: 2021, 2022, 2023
- Plant at 60,500 seeds per acre when fields were fit for planting
- Thinned to a common population, usually 175 plants per 100 ft row
- Defoliation: 3 dates in July and August
- Treatment: 0, 25, 50, 75 and 100% defoliation

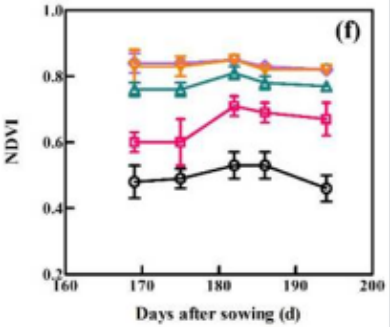


Materials and Methods

- Measure canopy health and calculate NDVI using RapidScan sensor.
- Harvest: root yield, % sucrose and recoverable sucrose per acre.
- Treatment design was a randomized complete block design and 4 replications.
- Treatment arrangement was a 2 factor factorial design; defoliation intensity and timing.
- Data are presented as a percent of the pooled root and sucrose yield

Vegetative index corroborates sugarbeet yield parameters

- Measure crop and soil reflectance at three wavelengths, red (670 nm), RE (730 nm), and NIR (780 nm).
- Active sensors utilize their own radiation source
- Useful for hail damage assessment, nutrient/ fertility experiments, and plant biomass measurements.



Plant, simulated hail, and harvest across environments

Year	Location	Plant	Defoliation 1	Defoliation 2	Defoliation 3	Harvest
2021	Ada, MN	May 5	July 14	August 3	August 17	September 28
2021	Hendrum, MN	May 5	July 15	August 2	August 16	September 26
2022	Crookston, MN	May 24	July 18	August 8	August 29	September 29
2022	Hendrum, MN	June 3	July 19	August 9	August 30	September 29
2023	Crookston, MN	May 11	July 10	July 30	August 14	September 29
2023	Hendrum, MN	May 16	July 6	July 30	August 15	September 28

We elected to drop Ada 2021 and Hendrum 2023 from the combined analysis due to intra field variation.

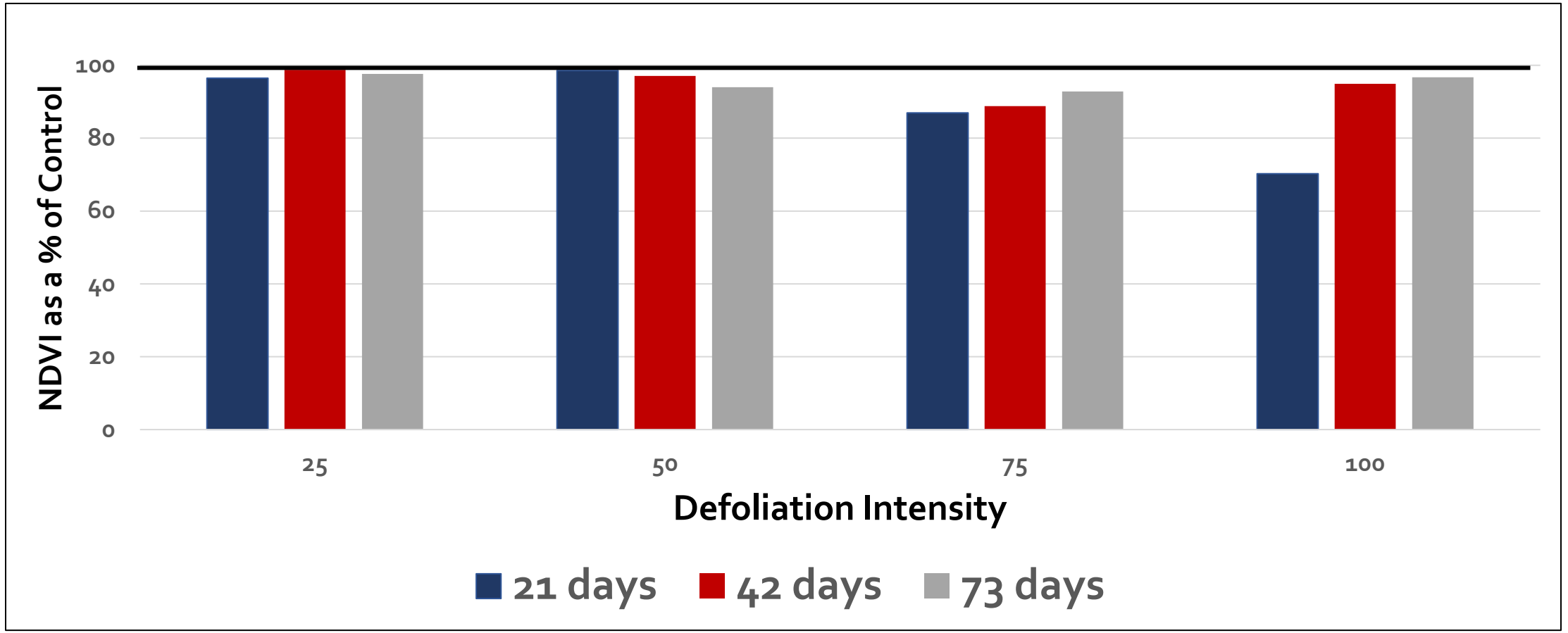
- Ada 2021 was very dry weather.
- Hendrum 2023 not sure why the data is variable.

Root yield and % Sucrose in control treatment, across locations and years.[a]

Year	Location	Root Yield with Control Treatment	% Sucrose with Control Treatment
		Ton/A	%
2021	Hendrum, MN	31.4	16.57
2022	Hendrum, MN	24.3	18.39
2022	Crookston, MN	28.6	18.95
2023	Crookston, MN	32.7	18.25

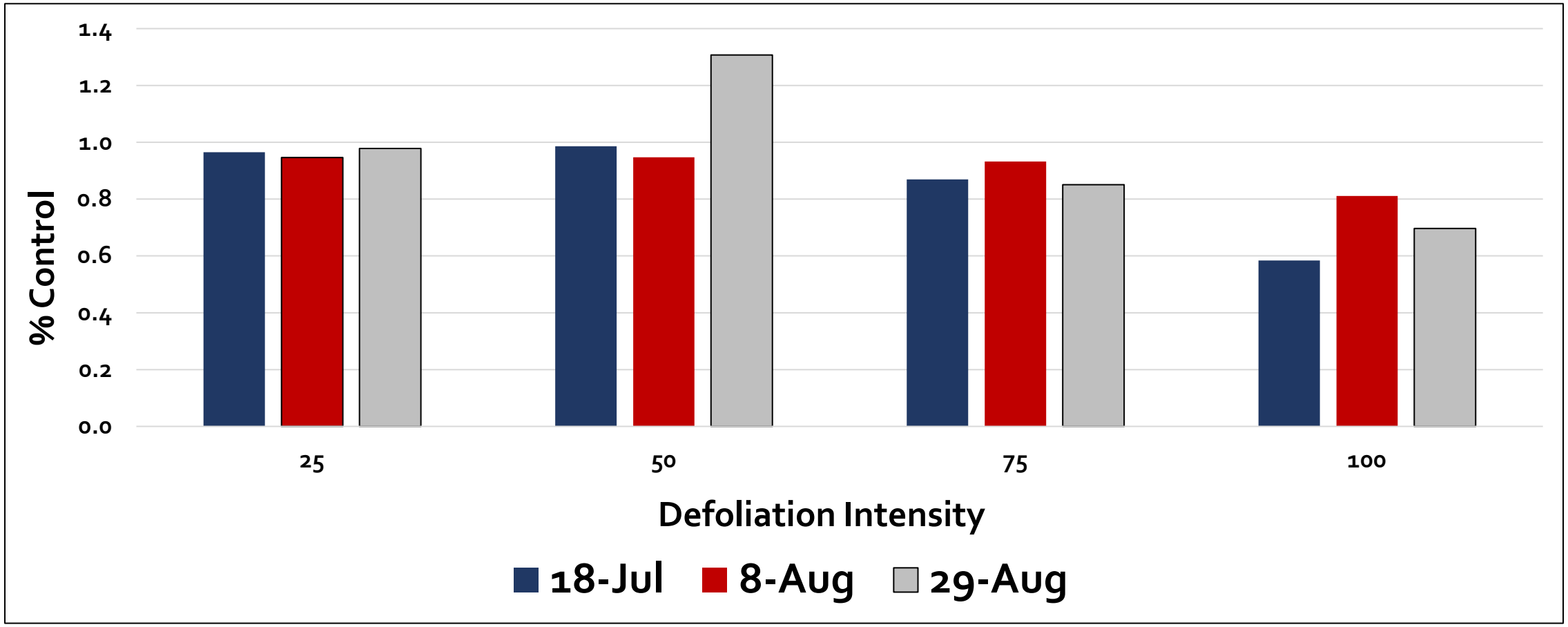
[a]Control treatment is 0% defoliation across simulated hail timing

NDVI[a] as a percent of the no defoliation treatment collected 21, 42 and 73 days after simulated hail event on July 18, Crookston MN, 2022.



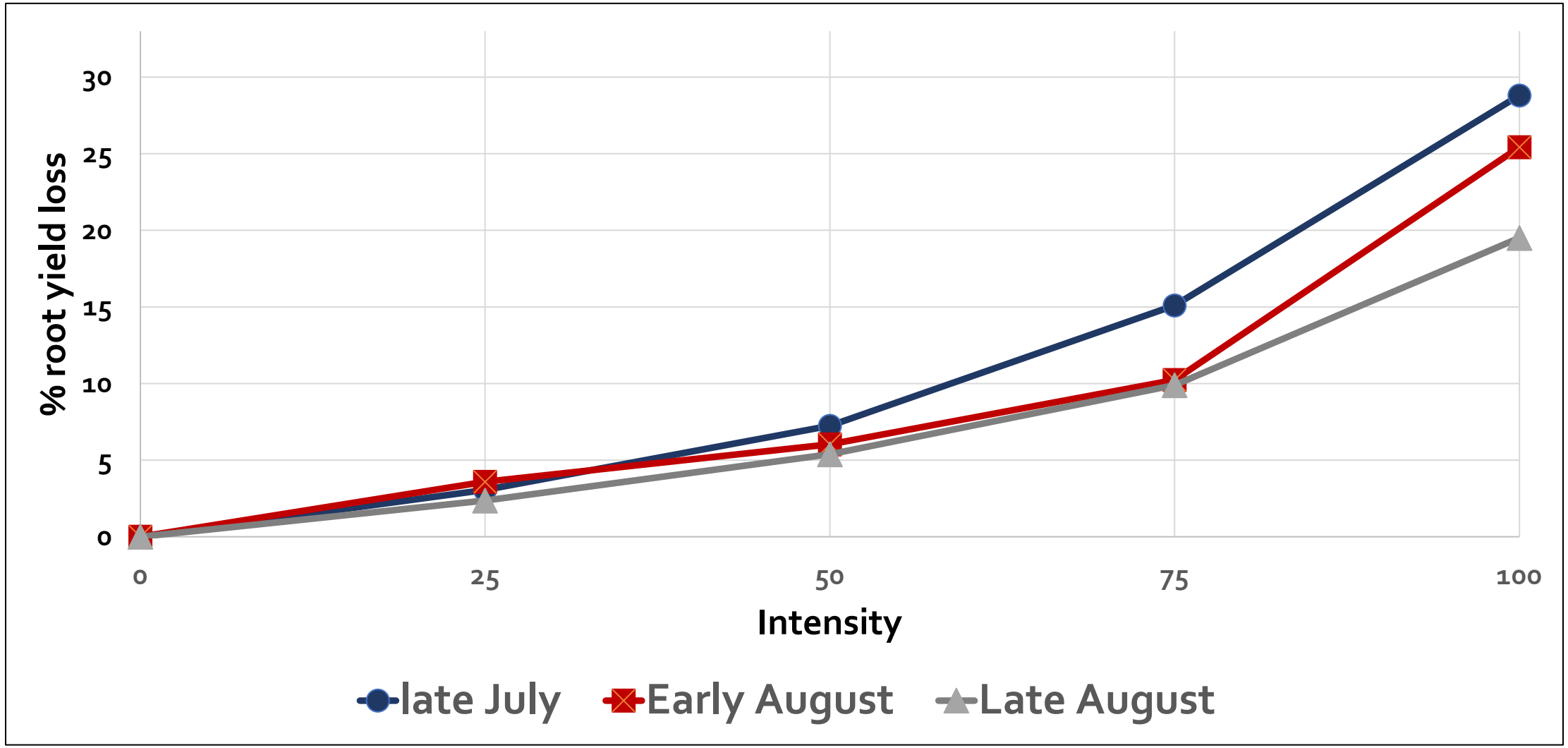
[a]Normalized difference vegetation index (NDVI) is an indicator of green healthy vegetation.

NDVI[a] as a percent of the no defoliation treatment collected 22, 23, and 24 days after simulated hail events, Crookston MN 2022

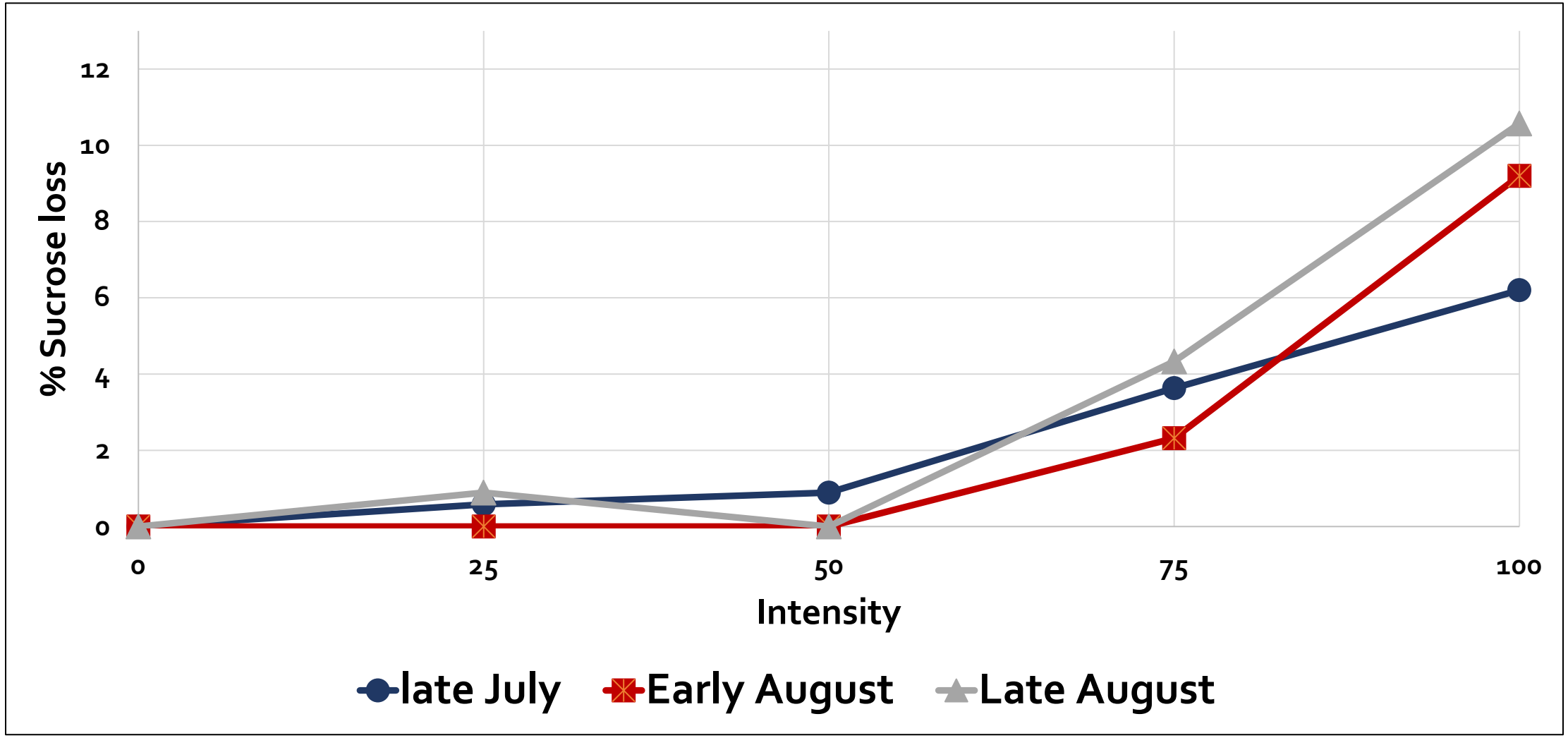


[a]Normalized difference vegetation index (NDVI) is an indicator of green healthy vegetation.

Percent root yield loss in response to intensity and timing of simulated hail, averaged across environments.



Percent sucrose loss in response to intensity and timing of simulated hail, averaged across environments.



Summary

- Loss of root yield increased as intensity of defoliation increased from 25% to 100%; sucrose yield loss at 75% to 100% defoliation.
- Loss of root yield was greatest from simulated hail in early July, especially at 75% and 100% intensity.
- % Sucrose loss at 100% intensity was greatest from simulated hail closest to harvest.
- Sugarbeet canopy recovers quickly, fueled by sucrose reserves.
- Assumptions about root and sucrose loss from hybrids grown in the 1950s, 1960s and 1970s hold true today.

Appendix

- Manage sugarbeet for bacterial leaf spot and Alternaria.
- Environmental conditions including rainfall and air temperature contributed to variation across years.