Understanding heat stress in Broccoli, Cauliflower and Brussels Sprouts

and implications for improved management.

Jason Plate, Jan van der Heide

BEJO SEEDS

- Physiological effects of Heat Stress
- Effects of soil fertility
- Effects of cool weather (vernalization)
- Problems caused by rapid growth (temperature dependent)

Stages of Plant Development

Vegetative Phase

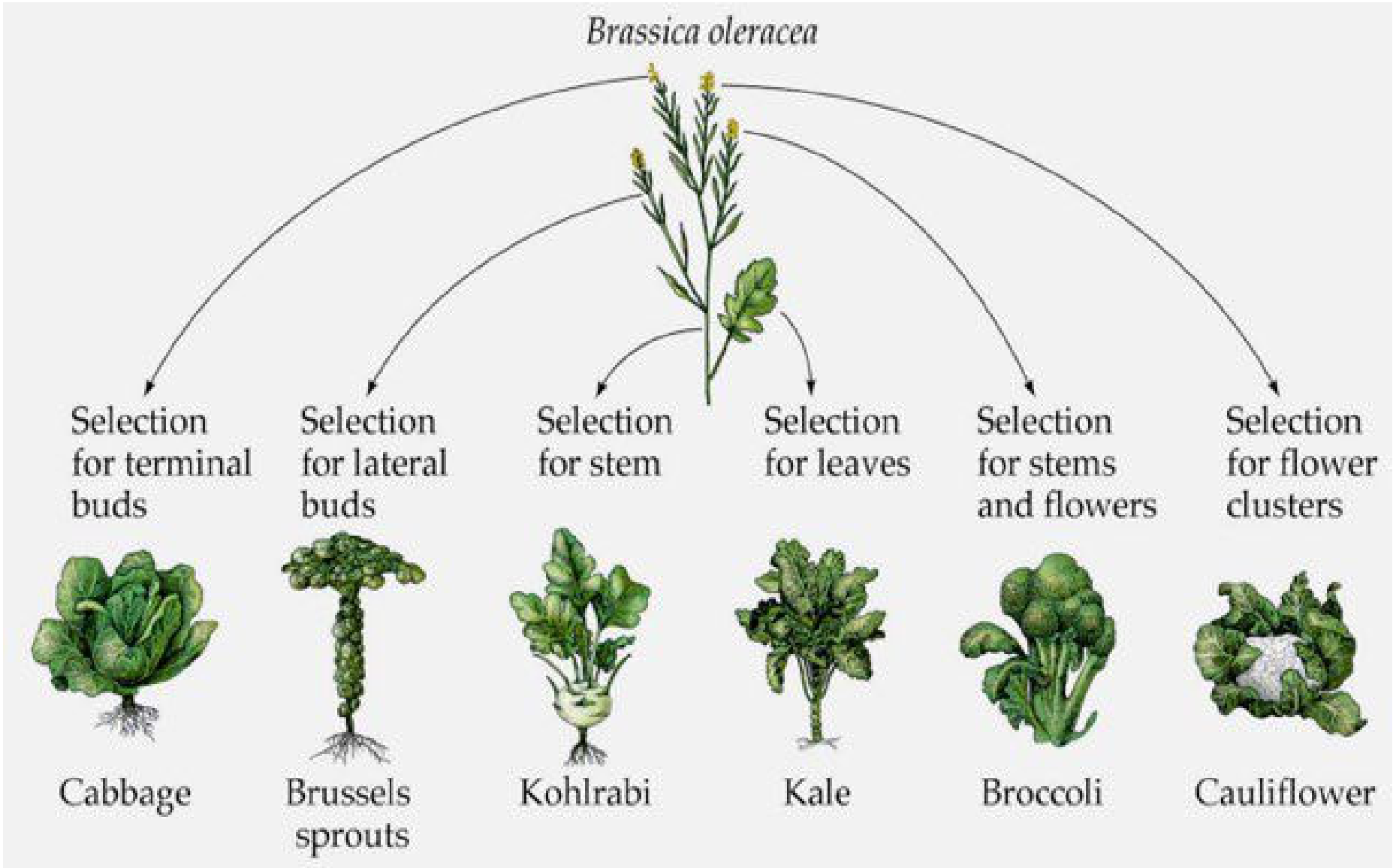
Development of stems, leaves, green tissues

Generative Phase

Development of reproductive structures

- Flowers
- Bulbs
- (lateral buds, sprouts, heads)

Brassica oleracea



Brassica oleracea

Broccoli, Cauliflower

- Switch from vegetative to generative phase

Brussels Sprouts, Cabbage

- Switch from vegetative to “heading” phase

Kale

- Purely vegetative (= easy!)

Effect of High Temperature

- Stimulation of vegetative development
  - Broccoli
    - development of side shoots
    - “leaf in head”
  - Cauliflower
    - Fuzz (sepal extension)
    - “leaf in head”
- Suppression of generative development
  - Broccoli
    - Flower abortion (ugly heads, cat-eye)
    - Delayed flowering, delayed harvest (also in cauliflower)

Effect of Nitrogen

Stimulates vegetative development

- Promotes leaf growth, green tissues

Can suppress/delay generative development

Effects of High N and High Temperature can be similar

BROCCOLI

- Can you grow good broccoli in July?

Effect of heat on flower bud development in Broccoli

Heat damage

- Temperature > 30 C (86 F)
- Early flowering stage: head is 2 mm (1/8 inch)
- Head is collection of older and younger buds
  - Buds develop from outside edge toward center of head
  - Flower buds are most sensitive to heat damage when very young
- High temperature inhibits development of sensitive buds
  - Uneven development of buds = ugly heads

- When the weather is “hot & sticky”
  - Hot days, and hot nights

- www.cornell.edu/bjorkman/lab/broccoli/broccoli.php

Early flower bud development

Normal

Heat Damage

From: Thomas Bjorkman


R3003
08/10/2011


R2993
08/10/2011


R3004
08/10/2011


R3001
08/10/2011


R5726
08/06/2011


R3009
08/10/2011


BROCCOLI
R 5778
08/12/2011


R3015
08/10/2011

HOLLOW STEM

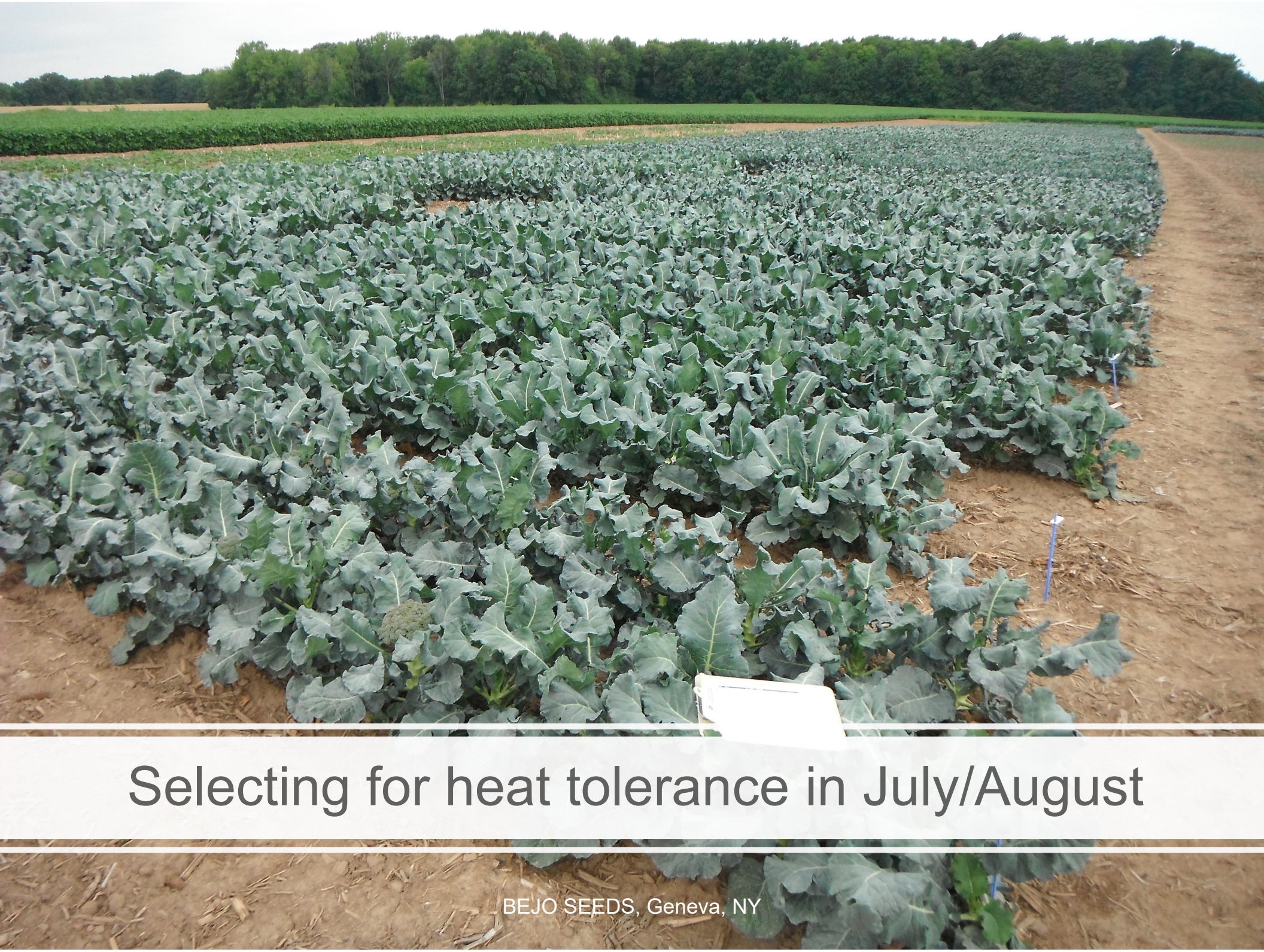
Managing Heat Damage

AVOIDANCE

- Plant in cooler season
  - Cooler night temps

BREEDING

- Select under warm weather conditions
  - Hot days & warm nights



Selecting for heat tolerance in July/August

BEJO SEEDS, Geneva, NY

SUMMER BROCCOLI new hybrids

Challenges

- Reducing sensitivity to heat stress
  - increase sensitivity to vernalization?

  - Heat tolerance = good quality in summer
  - flowering too early in cooler weather
    - *Small plants, smaller heads*

Sprouting Broccoli, SANTEE

Vernalization vs Heat Tolerance

SANTEE

- Late flowering
- Needs cold weather
  - No summer production

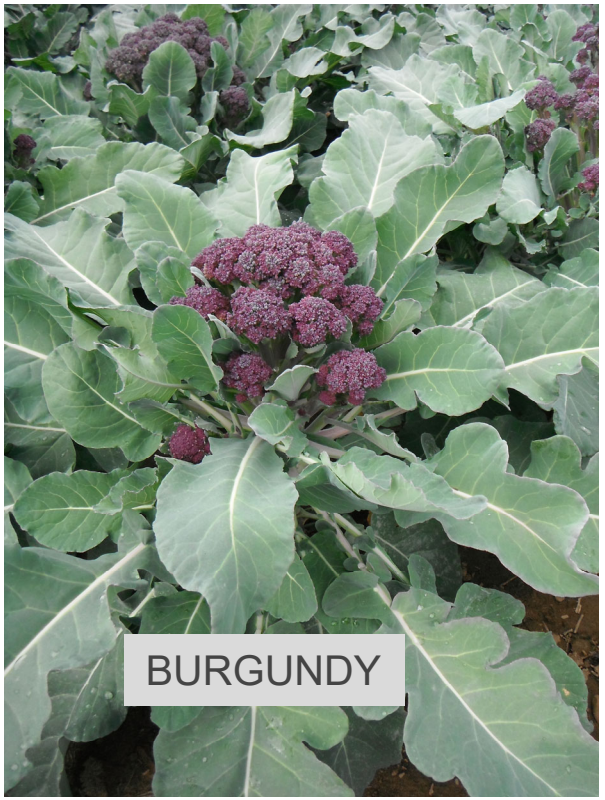
BURGUNDY (purple)

MONTEBELLO (green)

- Easy flowering
- Tolerates warm weather
  - Reliable summer production

SANTEE

MONTEBELLO



BURGUNDY

CAULIFLOWER

Cauliflower

- **Vegetative development:**
  - grow a large and healthy plant
    - Protection of developing head
  - Steady and even growth
  - Balanced fertility
  - Steady soil moisture (prevent tipburn)

CAULIFLOWER

- **Generative Development**
- Vernalization
  - Triggers flower development
  - Exposure to critical (low) temperature to trigger flowering which can differ dependent on type

Different CAULIFLOWER types
and their vernalization requirements

Tropical cauliflower	Summer cauliflower	Fall cauliflower	Winter cauliflower
• No vernalization requirement • Needs constant high temperature	• Low vernalization requirement • will flower in warmer weather	• Medium vernalization requirement • will flower when days and nights get cooler	• High requirement • will flower only after long exposure to cold weather

Which type should you plant?

- Tropical cauliflower
  - Will flower in transplant tray, not for here!
- Summer cauliflower
  - Maturity 65 – 75 days
    - Will flower too soon in fall, low production, small heads
- Fall cauliflower
  - Maturity 80 – 95 days
    - Will not flower in summer (delay), uneven maturity in heat, late harvest in warm fall
- Winter cauliflower
  - Maturity 100 – 240 days
    - Normandy, Brittany (no-frost winters)
    - Not for here!

Cauliflower vernalization
-- challenges --

- Vernalization requirement too low
  - Flowers too easily and too soon, poor quality
- Vernalization requirement too high
  - Difficult to predict flowering time
  - Delays flowering when too warm (= late harvests)

- Medium vernalization requirement
  - Reliable flowering in summer?
  - Only when weather is predictable….

Tipburn

Prevents complete development of wrapper leaves

No protection of the curd, low quality

Loose curds

rapid growth, poor field holding

STEADY grows more quickly than TOLEDO

FUZZ

Flower sepals elongating (high temperature)

Summer varieties to try

reliable and even maturity, good quality

BERMEO - *earliest*

FLAMENCO – *mid season*

Fall varieties

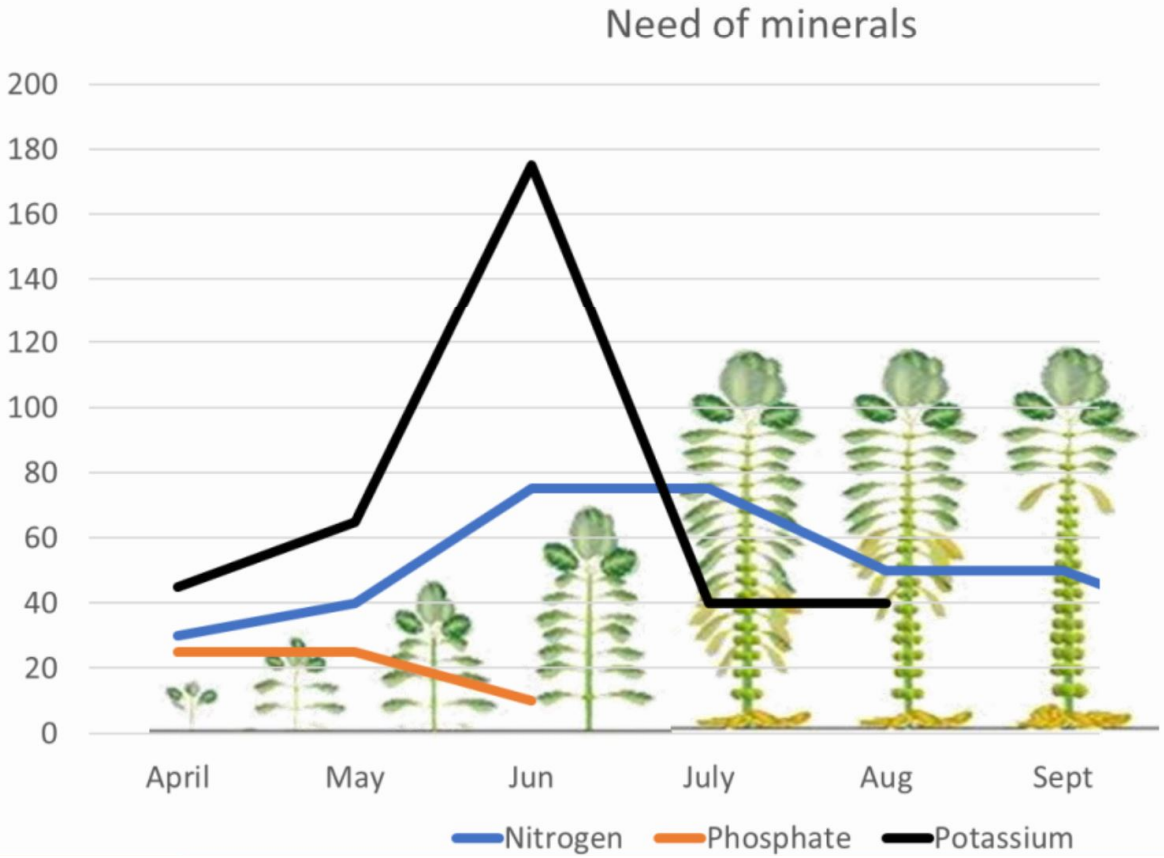
slower-growing, bigger plants, good quality

ADONA

TOLEDO

Brussels Sprouts

Element uptake during season



Element	kg/ha
P205	60
N	250 - 350
K2O	360
SO3	250
MgO	30
CaO	150

Brussels Sprouts -- Ideal situation:

- Rapid growth in first half of season
  - Front-load fertilizer
- Maximum height 2/3 of season
- Sizing of sprouts
  - “topping” when 80% of sprouts reach marketable size
    - Earlier maturity, but a bit less yield
- Fertility used up by end of season
  - Nutrients in leaves are re-distributed to form sprouts
  - Leaves die and fall off
    - “naked” stems with green sprouts

Ideal situation

- Straight stems
- Shed leaves
- Clean and green sprouts

Brussels Sprouts – reality:

- **Heat stress in mid-summer**
  - No growth
  - Loss of production
  - Water stress, calcium deficiency
    - Tipburn (internal), breakdown of lower sprouts
  - Maturity delay (crop scheduling)

- Loss of apical dominance during no-growth
  - Bottom sprouts start sizing too soon at re-growth
    - Uneven sizing
    - Funky sprouts

Dealing with mid-season heat stress

- Irrigation, if possible
- Plant early
  - Make length before stress begins
- Use vigorous varieties
  - It takes a few years to get experience with varieties
  - How much fertilizer?

Crop needs:

200 – 250 #N/acre

200 – 300 #K/acre

60 – 100 #P/acre

Effect of planting time

July

June

May

Date of picture: 5 November, 2018

L to R: DIVINO, MARTE, DAGAN
Guard rows: FRANKLIN

May planting

some lodging, some over-mature, highest yield

June Planting

Good length, top sprouts still small

July Planting

Shortest plants, clean sprouts, low yield

DAGAN

good vigor, less field holding ability

May

June

July

Picture date: 19 October, 2018

MARTE

best vigor, good field holding

May

June

July

DIVINO

least vigor, best quality

May

June

July

Quality Issues

Funkiness of lower sprouts

- Physiological disorders
  - Tip burn, “Summer Frost”
    - Caused by environmental stress
  - Alternaria can invade weakened tissues, but is often not the primary cause

Funky Sprouts

Funky Sprouts

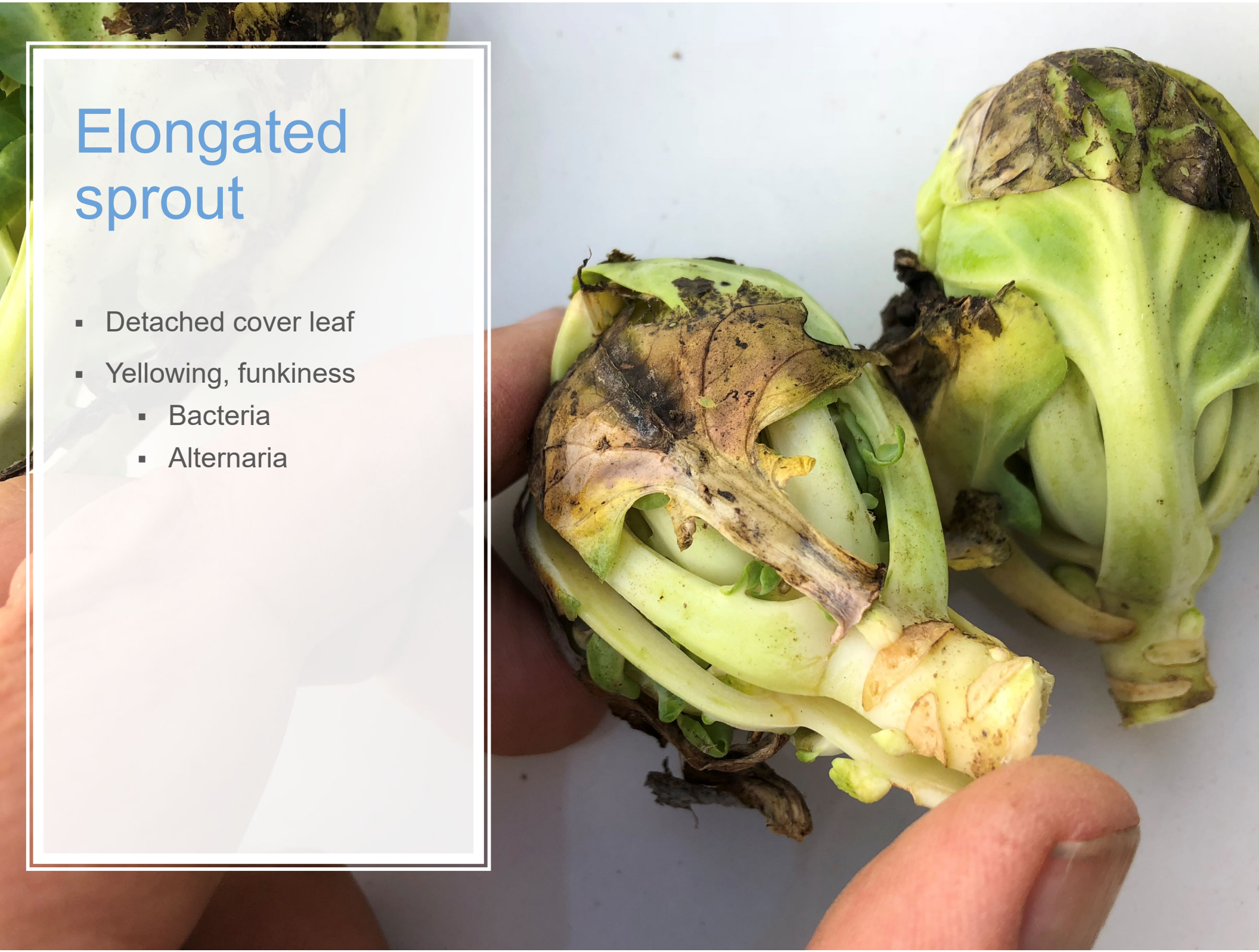
SNAILS

Elongating sprouts

loss of apical dominance, halted growth (heat stress)
lower sprouts develop too early at re-growth and stretch

Elongated sprout

- Detached cover leaf
- Yellowing, funkiness
  - Bacteria
  - Alternaria



“Summer Frost”

internal tip burn, calcium deficiency (lack of soil moisture)
(similar to Blossom End Rot in tomato, pepper)

Summer Frost/Tip Burn

-- peeling down the layers --

Layer 1

Layer 2

Layer 3

Layer 4

Rotting Sprouts

weakened tissues infected with soft rot bacteria

Thrips damage

Broccoli, Cauliflower, Brussels Sprouts

….much more challenging than KALE!

more information

Bejo Seeds

1088 Healey Road

Geneva, NY 14456

315-789-4155


bejo