PROCESSING TOMATOES

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Processing Tomatoes

Topics

- Farm statistics from USDA
- Production timeline
- Growth and fruit development
- Mineral nutrition/fertilization
- Pest Management

Tomato Acreage, Production, Value and Rank*

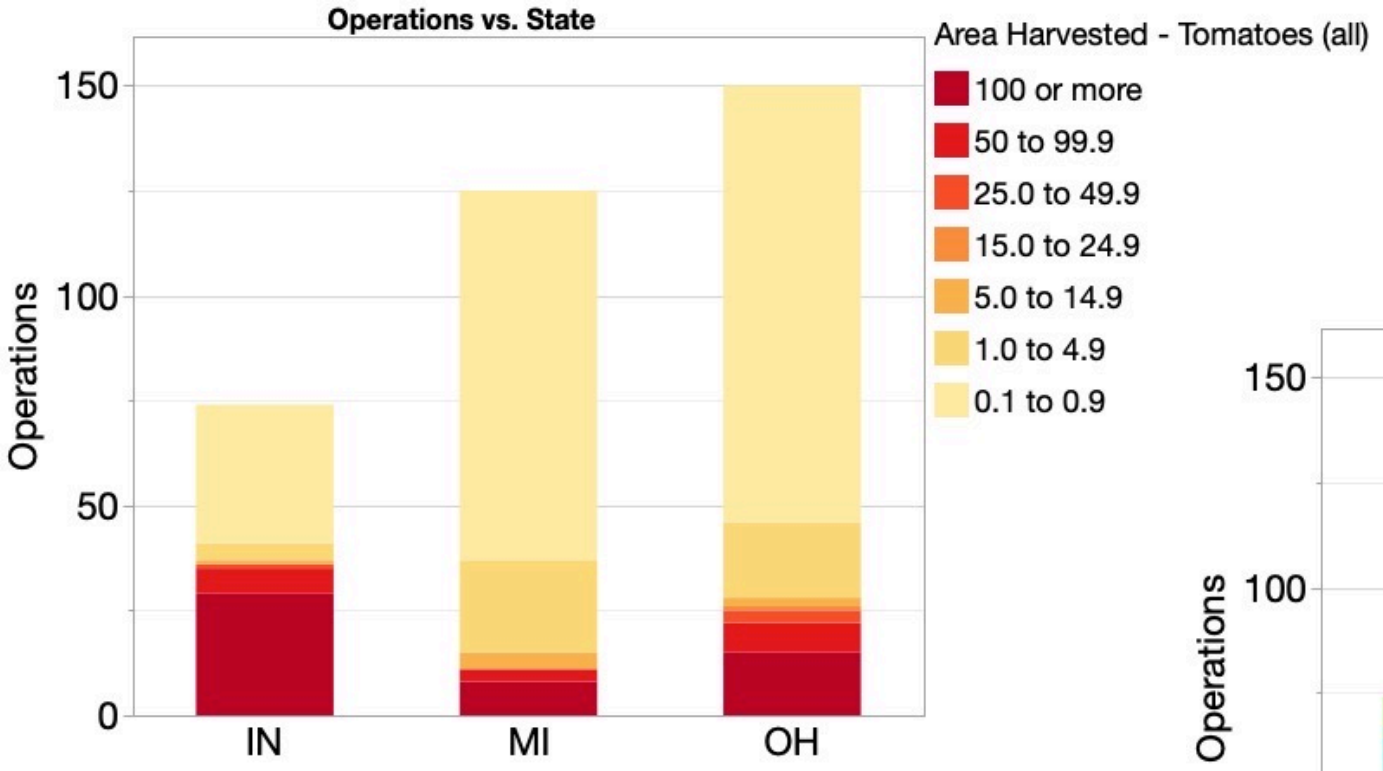
State	Farms	Acres	Production (million tons)	Value ($ million)	Rank
CA	344	228,918	12.285	970	1
IN	74	7,113	.244	28	2
MI	125	2,938	.113	12	3
OH	150	3,626	.112	13	4

*Tomatoes for processing.

Farms and acres: USDA 2017 Census of Agriculture – State Data Table 29. Processing tomatoes

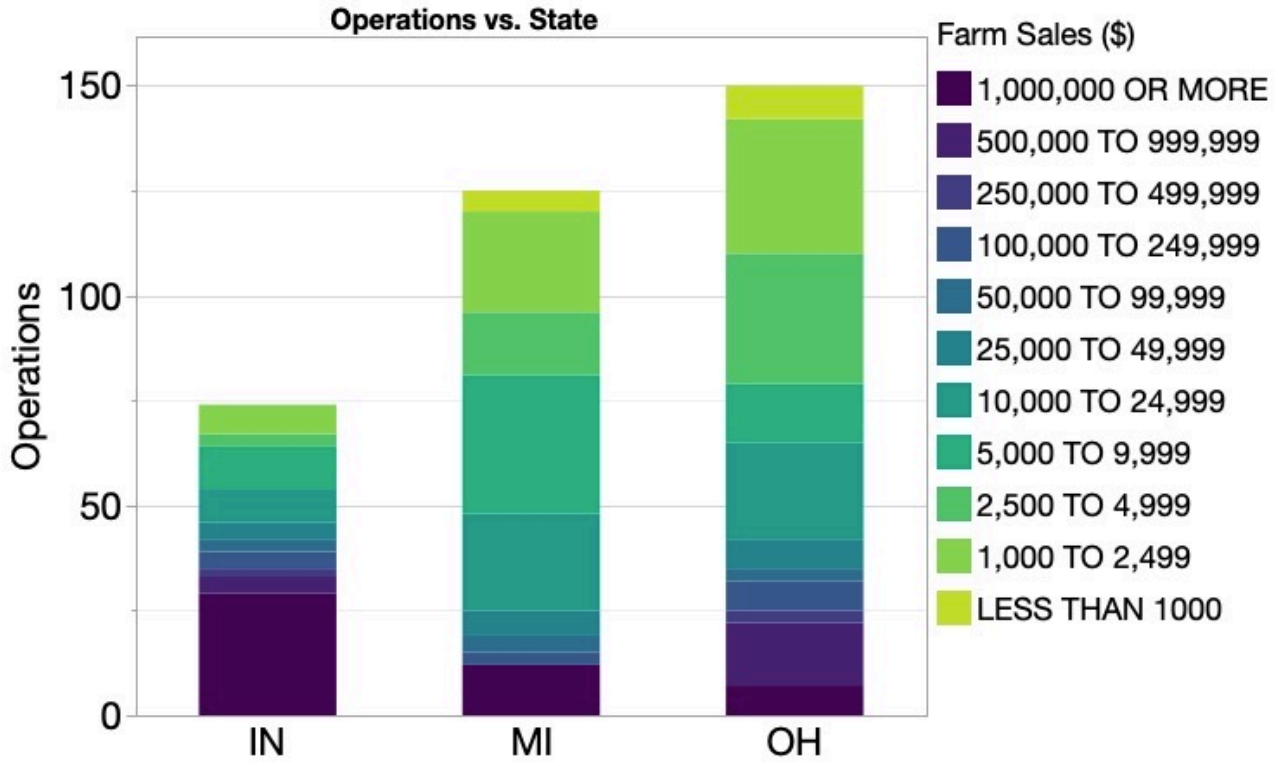
Utilized production and value: Vegetables 2018 Summary, USDA NASS

Tomato Operations by Area Harvested and Farm Sales*



Indiana has fewer, larger operations

- Half with at least 25 acres processing tomatoes
- 39% with farm sales more than $1,000,000



Source: USDA NASS Quick Stats. Accessed 4 Oct. 2021. https://quickstats.nass.usda.gov/results/257E0FBD-83A1-3C55-9EF0-DC917C2E1810

*Operations with processing tomatoes

Location of Tomato Operations

Map from Driftwatch.org

- Northwest Indiana
- Central / East Central Indiana
- Southeast Michigan
- Ohio not shown

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March – April: Grow seedlings
May – mid-June: Transplant
June – early July: Flowering and fruit set begin

July – August: More fruit set and fruit development
August – Sept. – Oct.: Fruit ripening and harvest

Apr. | May | June | July | Aug. | Sept. | Oct.








Seed to transplant: 4-6 weeks
Flowering: ~21 days after transplant (DAT)
Harvest: ~100 DAT

Processing Tomato Timeline

Fall after harvest:
Seed cover crop
Fall fertilizer application (if needed)
Make beds for following spring

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Fruit set on main stem and branches

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1/4 to 1 1/2 in.

Site Selection

- Well-drained
- No nightshade family crop in previous 2 years
- Be aware of herbicide rotation restrictions
  "Crop Rotational Restrictions" on pesticide label
- Irrigation? (~45%-50%)

Soybean Herbicide Rotation Restrictions

This is rotational restriction information for soybean herbicides. The products are list
Name(s), with the **Number of Months** you must wait to plant different vegetables af

AT=anytime herbicide labeled for the crop or no rotation restriction exists
FB= field bioassay required before planting the crop
NNY= not next year, the crop cannot be planted the following year
NY=the crop can be planted the year after application
V=variable, intervals vary by crop variety or other conditions specified on label
*Transplanted tomatoes only
**In Indiana only, 18m for transplanted tomatoes and peppers, cabbage, melons, and

Trade Names	Number of Months				
	Tomato	Pea	Snap Bean	Sweet Corn	Cucurbi
Authority Assist	30+FB	10	10	18	30+FB
Authority First, Sonic	30+FB	9-12-30+FB,V	30+FB	18	30+FB
Boundary	12	8	12	4	12
Canopy, Canopy EX	9-10[2]	9-12	9-12	18	18-30V
Classic	10[2]	12	12	18	18-30
Command	9	AT	9	9	AT

https://mwveguide.org/

Trade Names	Tomato
Authority Assist	30+FB
Authority First, Sonic	30+FB
Boundary	12
Canopy, Canopy EX	9-10[2]
Classic	10[2]
Command	9
Envive	12*
Extreme	18-40+FB,V
First Rate	18
Flex Star	10[2]

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Mineral Nutrition

- Soil sampling and testing
- pH 6.0-6.8
- Nitrogen
- Phosphorus
- Potassium
- Micronutrients
- In-season tissue test

Macronutrients - Uptake

Uptake in Pounds per Ton of Harvested Fruit

	Vine + Fruit	Fruit
N	4.8 – 5.6	3.2 – 4
P2O5	1.6 – 2.0	1 – 1.4
K2O	6 – 9	5 – 7

Source: modified from UC Davis Agriculture and Natural Resources
http://ceyolo.ucanr.edu/files/53268.pdf

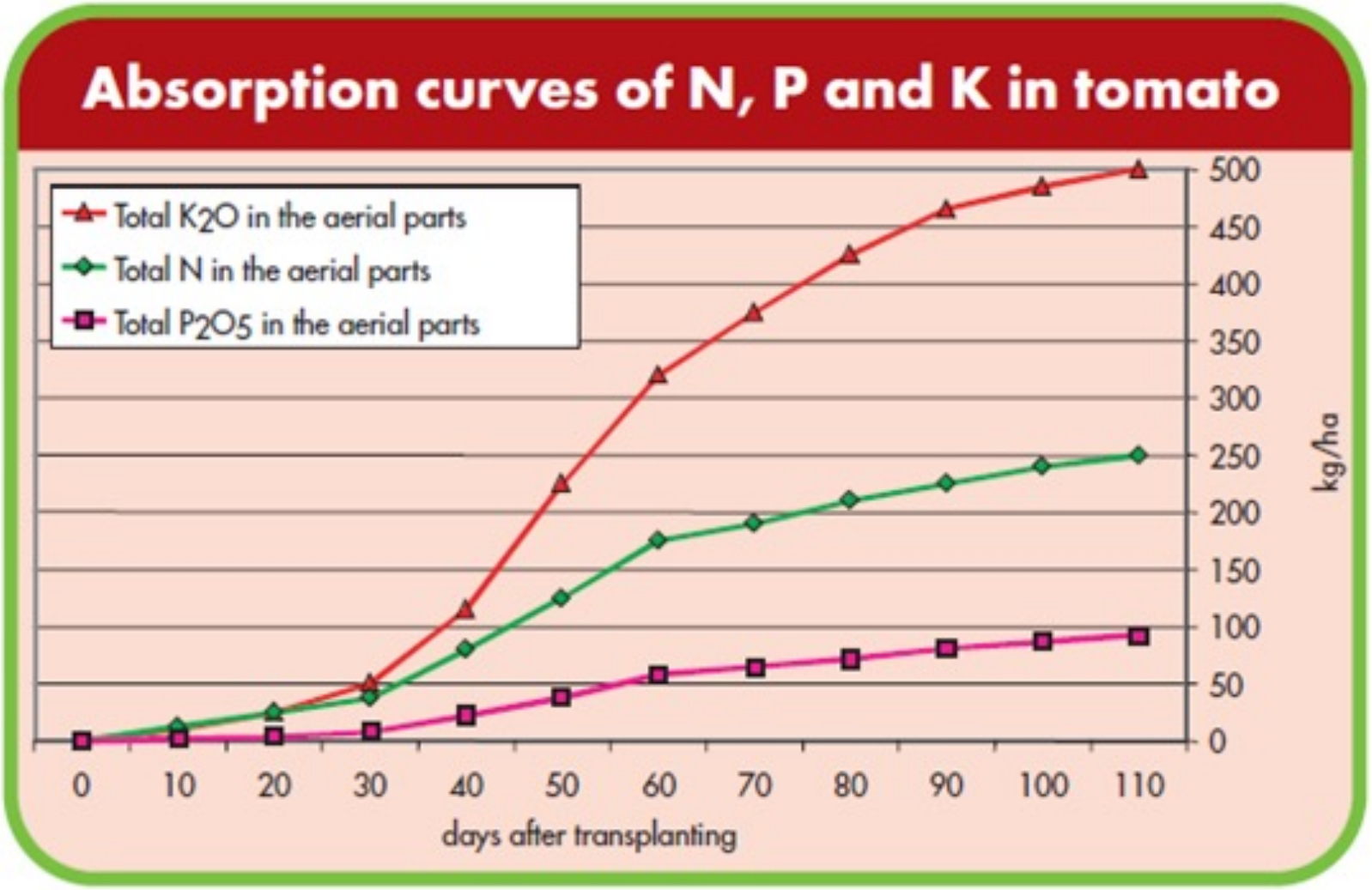
Macronutrients – Crop Removal

Estimate Nutrient Removal Based on Yield

Ele-ment	Est. Removal (lb/ton)	Yield (tons/A)				
		30	35	40	45	50
P2O5	1.45	44	51	58	65	73
K2O	7	210	245	280	315	350

Source: C. Utterback

Macronutrients - Uptake



Yield: 90 MT/ha=36 tons/A
100 kg/ha = 89 lb/A
250 kg/ha = 223 lb/A
500 kg/ha – 446 lb/A

Source:
https://sqmnutrition.com/en/esays/tomato-nutrition-management/

Nitrogen Fertilization

Common Practice

- Total N: 90 – 150 lb./A
- Preplant plus side-dressing
- Sidedress shortly before bloom, 2 to 3 weeks after transplant
- Use N stabilizers with preplant application
- On coarse soils, split application is especially important

N Application Rate Influenced by:

- Soil type
- % Organic matter
- Prior crop

N: 62 lb./A

95 lb./A

223 lb./A

Nitrogen rate influence on processing tomato yield and maturity

2012 Wanatah, IN

Phosphorus Fertilization

Recommendations based on soil test (Bray P1)

- Less than 45 ppm P: apply to build up soil P plus replace P removed in harvest

  Buildup = (45 – Soil Test) X 5

  For 30 ppm: (45 – 30) X 5 = **75 lb. P2O5/A**

  Crop removal = 1.5 lb/ton X tons/A

  For 50 ton yield: 1.5 X 50 = **75 lb. P2O5/A**
- 45 – 80 ppm P: apply to replace P removed in harvest
- More than 90 ppm P: no fertilizer P needed

Source: Warncke et al., 2004. Nutrient Recommendations for Vegetable Crops in Michigan, E2934. Michigan State University Extension, East Lansing, MI. https://www.canr.msu.edu/fertrec/uploads/E-2934-MSU-Nutrient-recomdns-veg-crops.pdf

Potassium Fertilization

Recommendations based on soil test (ammonium acetate)

- Sandy soils, CEC < 5
- Less than 88 ppm K: apply to build up plus replace crop removal

  Buildup = (88 – Soil Test) X 1.25

  For 50 ppm: (88 – 50) X 1.25 = **48 lb. K2O/A**

  Crop removal = 7 lb/ton X tons/A

  For 50 ton yield: 7 X 50 = **350 lb. K2O/A**
- 88 – 118 ppm K: apply to replace K removed in harvest
- More than 138 ppm K: no fertilizer K needed – for YIELD

Potassium Fertilization

Recommendations based on soil test (ammonium acetate)

- Loam and clay soils, CEC > 5
- Less than 105 ppm K: apply to build up plus replace crop removal

  Buildup = (105 – Soil Test) X 1.6

  For 50 ppm: (105 – **50**) X 1.6 = **88 lb. K2O/A**

  Crop removal = 7 lb/ton X tons/A

  For 50 ton yield: 7 X 50 = **350 lb. K2O/A**
- 105 – 149 ppm K: apply to replace K removed in harvest
- More than 149 ppm K: no fertilizer K needed – for YIELD

Potassium Fertilization

Split Applications Suggested

- Before crop and one or more applications in crop
- Sandy soils:

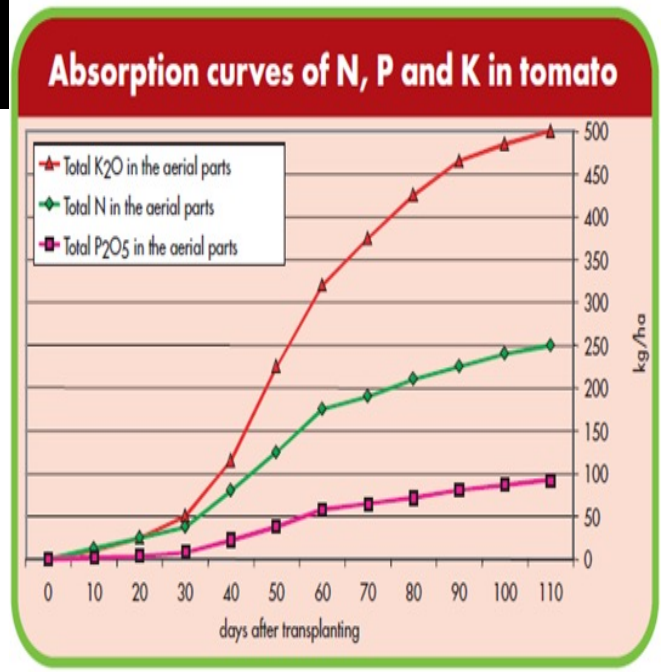
  1/3 pre-crop

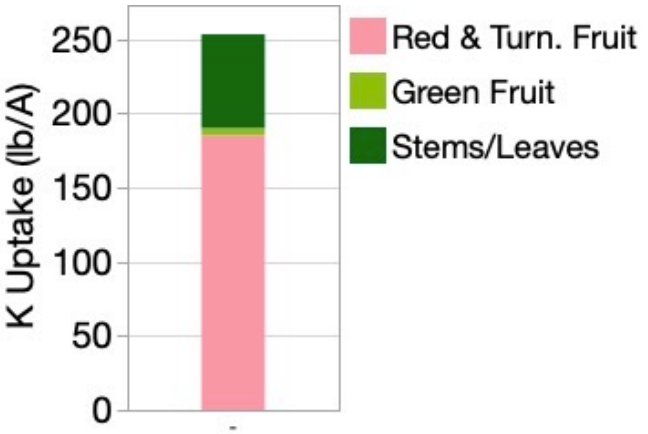
  2/3 before flowering
- Heavier soils:

  2/3 pre-crop

  1/3 before flowering

Potassium should be in soil when crop needs it; don't get behind





2012 Wanatah, N rate 134 lb./A

Lack of K can result in ripening problems including color disorders; low acidity and precocious seed germination; soft, mushy or mealy texture, and puffiness.

Potassium Rate (lb/A)	Fruit with precocious germination (%)
0	1.67
150	0.97
275	0.63
400	0.21

Slide courtesy David Francis, Ohio State University

Transplant Production

- Greenhouse-grown
- Plug trays, e.g. 228-cell
- Contract producers
- 4 to 6 weeks
- Critical time for disease management

Transplanting

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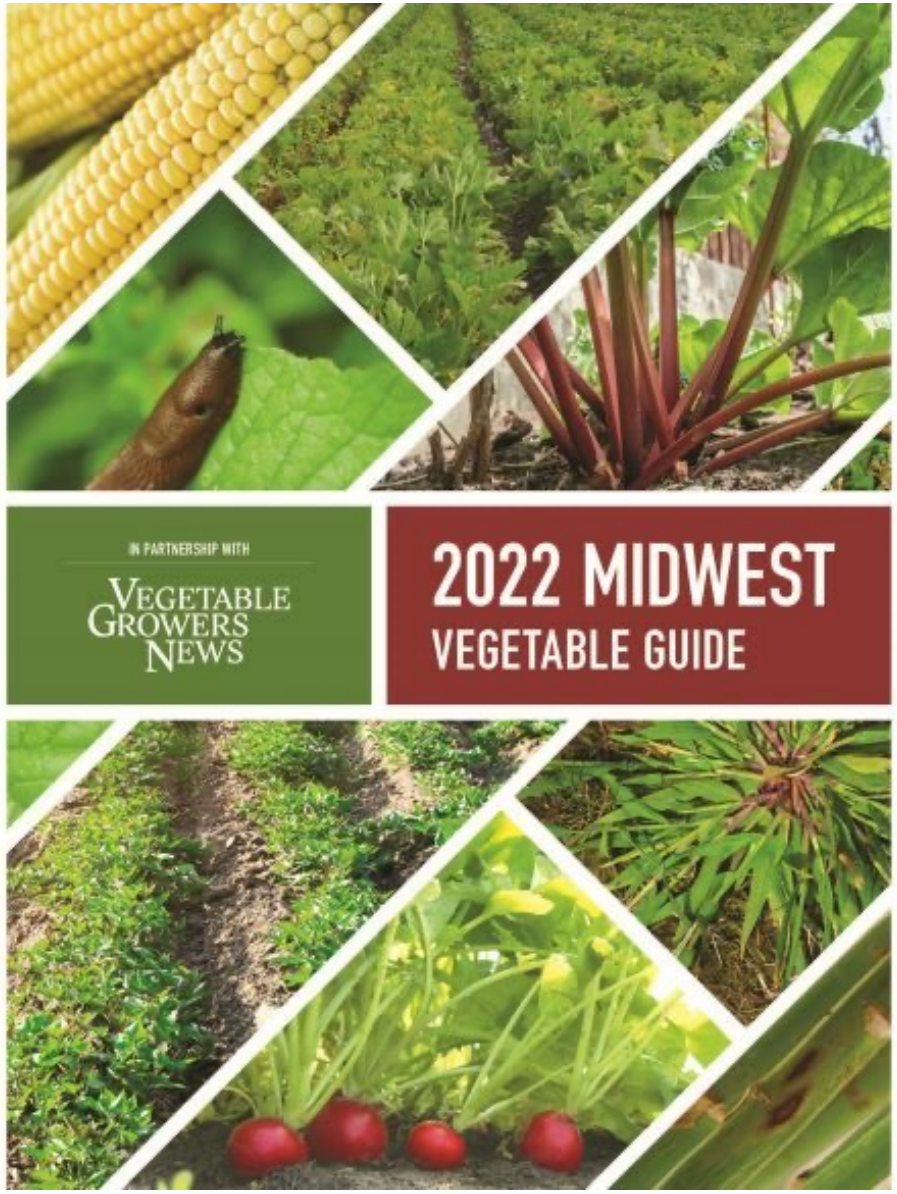
Management Guide

mwveguide.org

- Interactive online database
- Updated yearly
- New sorting functions for recommendations
  - REI
  - PHI
  - OMRI-listed
  - Chemigation allowed
  - Non-Restricted Use Pesticides



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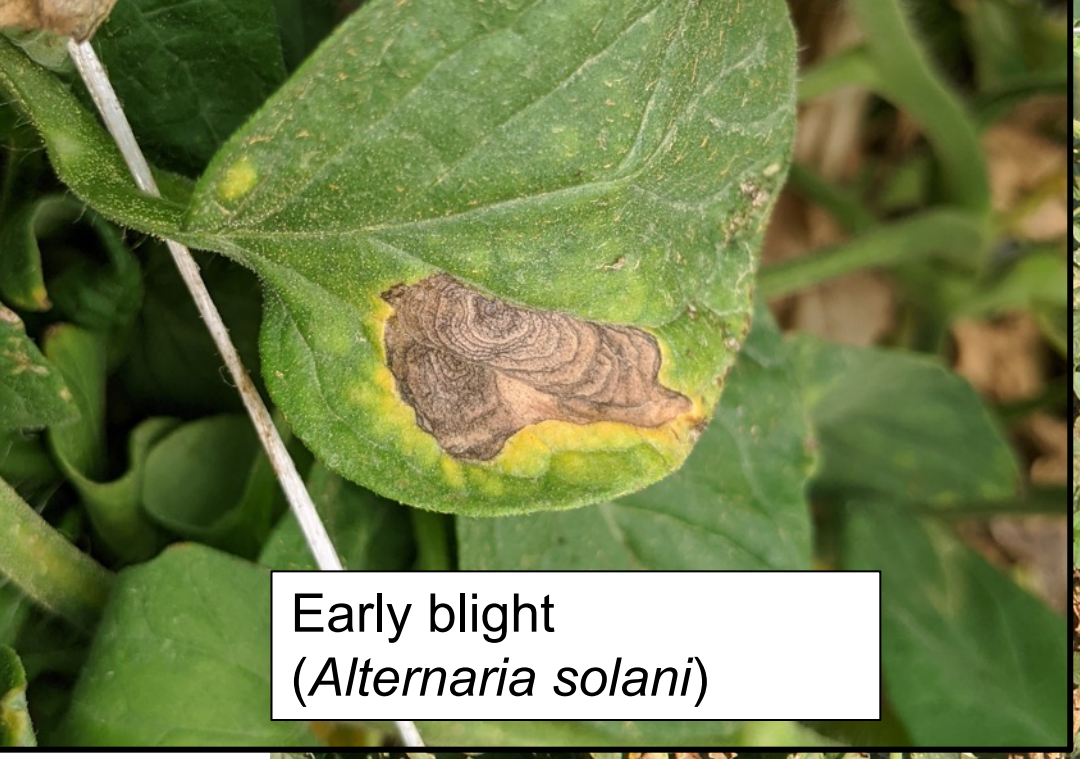
Disease Management

- Bacterial spot
- Bacterial speck
- Alternaria alternata and Alternaria solani



Early blight
(*Alternaria solani*)

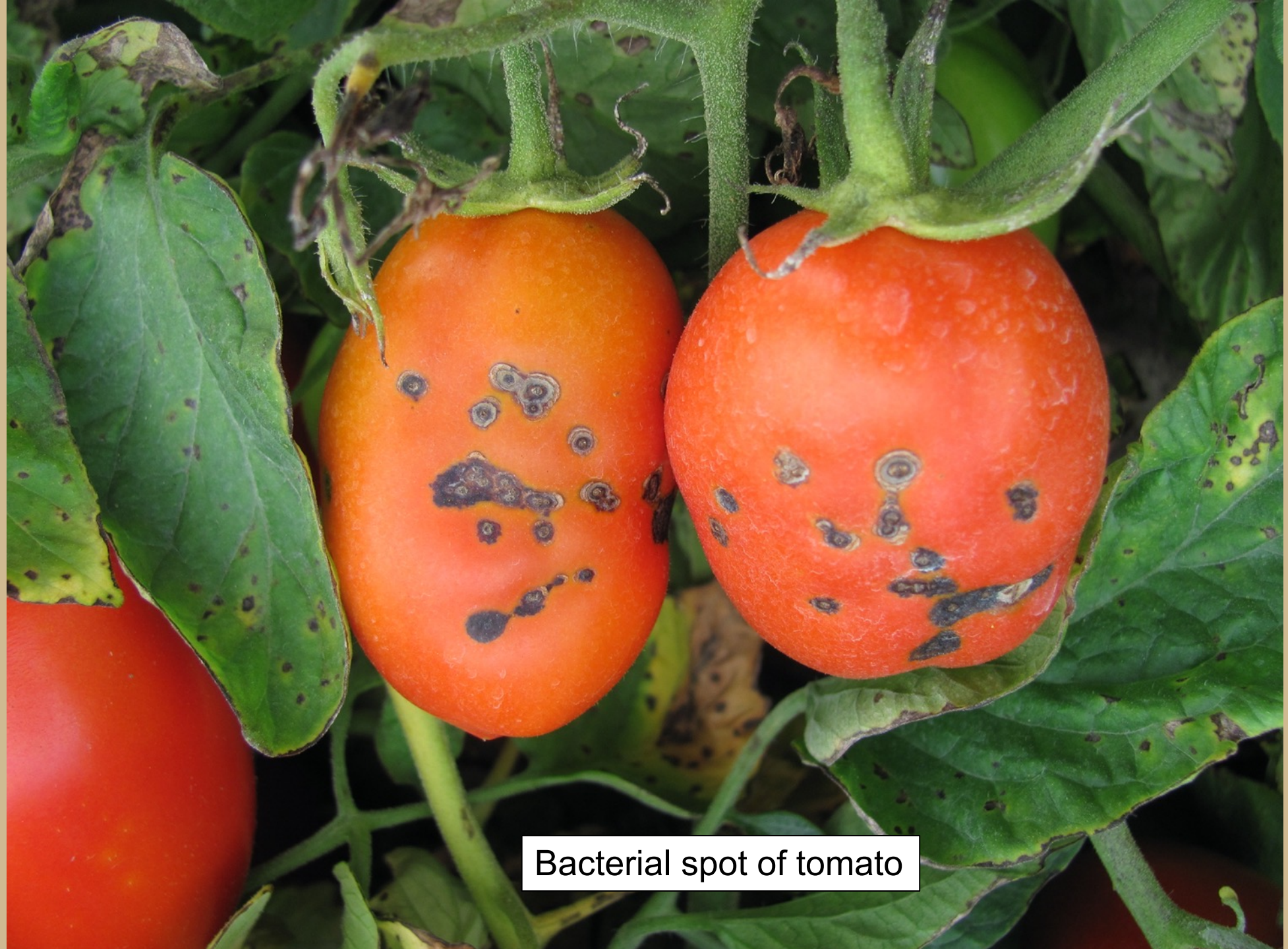
Septoria leaf spot

Necrotic old leaves may be a symptoms of early blight or Septoria leaf spot

Disease Management

Early blight/Septoria leaf spot fungicides

- EBCD (M3)
- Chlorothalonil (M5)
- Aprovia Top (7, 3)
- Revus Top (40, 3)



Bacterial spot of tomato

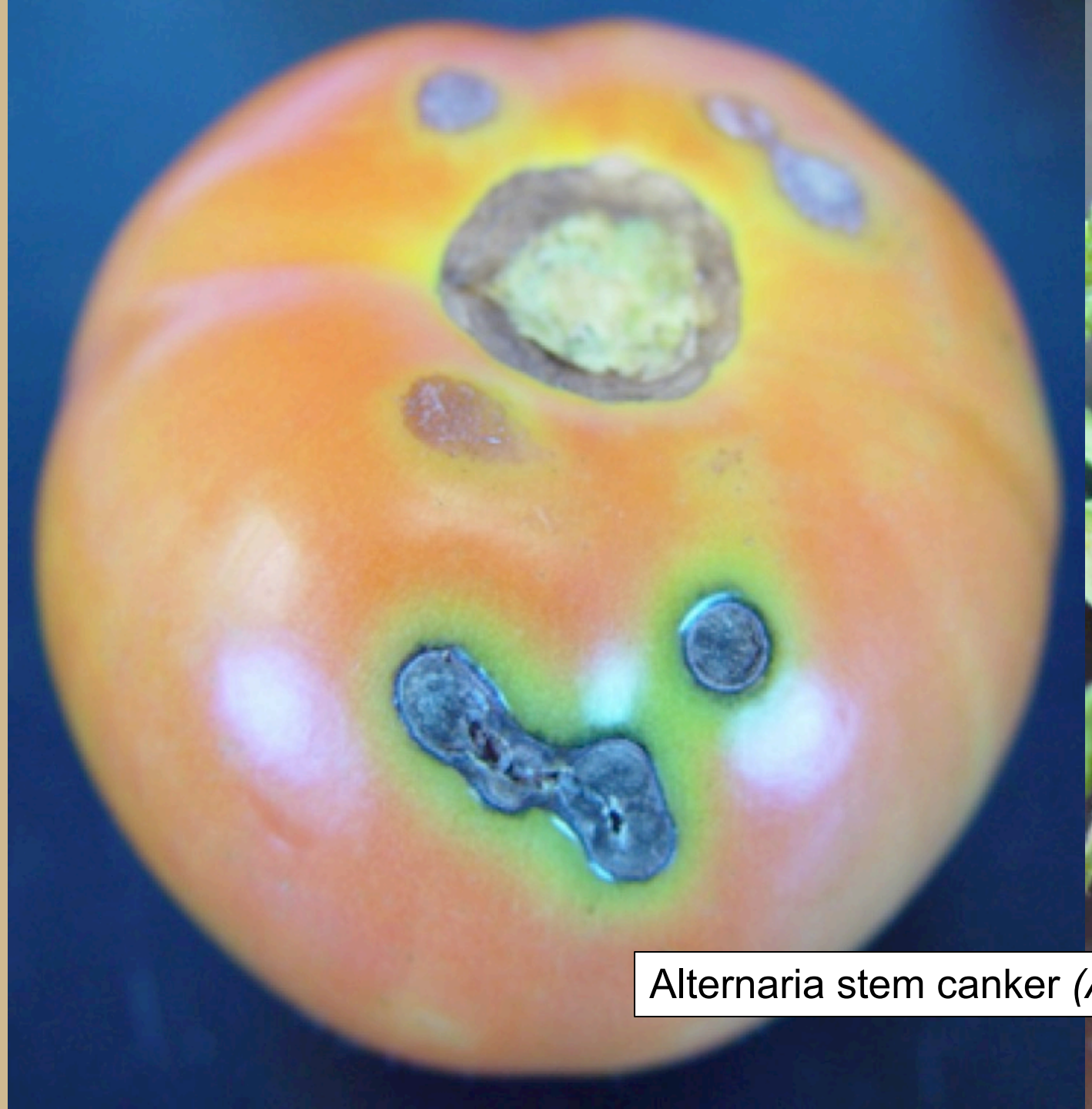
Disease Management

Bacterial spot products

- EBCD-only when mixed with copper products

  A 2016/17 Indiana survey found over 80% strains copper resistant.
- Actigard-works by ‘telling’ plant it is under attack.

  May cause yield loss if plants are stressed.
- Oxidate products-Kills bacteria on contact—no residue. Use 1% v/v when used alone. Use 0.39% if mixed with copper (Oxidate 5.0).



Alternaria stem canker *(A. alternata)* -University of Florida

Disease Management

Alternaria stem canker products

- ASC has been reported in Indiana, but not officially confirmed

  Send sample to PPDL for confirmation
- Aprovia Top; chlorothalonil; Revus Top.
- Resistant varieties available.

Disease Management

White mold of tomato fungicides

- Cabrio; Endura – list white mold of tomato on label

  Apply at flowering
- Switch 62.5 & Luna Tranquility

  Labeled for tomato & white mold on other crops

  Switch labeled for early blight; Luna T labeled for early blight, A. alternata, Septoria.

  Still best applied at flowering.

Insect Management

Who are the pests and when do we need to be monitoring?

- Foliage Feeders
  - Primarily feed on leaves/stems
  - Monitor crops after emergence/transplant, most susceptible
  - Generally, tolerate higher populations compared to fruit feeders
  - High levels of damage stunt plant growth, fruit production, lead to sunburn
- Fruit Feeders
  - Mainly attack fruit at any stage of development
  - Low tolerance, direct impact on fruit grade

Insect Management

Foliage feeders

Aphids, photo by J. Obermeyer

Cutworm and damaged plants, photo by J. Obermeyer

Colorado potato beetle, photo by J. Obermeyer

Flea beetles, photo by J. Obermeyer

Insect Management

Fruit feeders

Tomato fruitworm (corn earworm), photo by G. Brust

Tobacco hornworm, photo by J. Obermeyer

Yellow-striped armyworm, photo by J. Obermeyer

Stinkbugs, photo by J. Obermeyer

Typical Disease and Insect Management

- 15 weekly sprays beginning 7 days after transplanting
- At least two fungicides/bactericides in most sprays
- Insecticide included in first 6 sprays if needed, based on scouting
- Insecticides included in week 7 spray and then every other week until week 13, then weekly and based on scouting

Weed Management

Cultural, Mechanical, Chemical

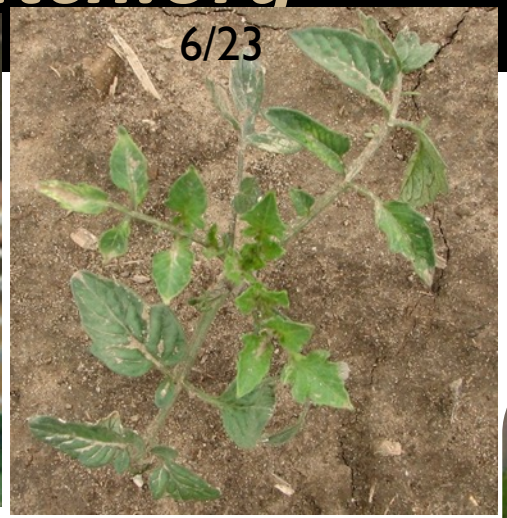
- Tillage and Cultivation
- Preemergence herbicides
- Postemergence herbicides
- Weed management in rotational crops

Herbicides for Tomatoes 2022, Indiana Adapted from: mwveguide.org

Common Name	Application Relative to Crop			Incorp.	Timing Relative to Weeds		Weed Groups Controlled			HRAC Code
	Pre-TP	Post-TP-Bet.Rows	Post		Pre	Post	Grass	BL, small seeded	BL	
DCPA			X		X		X	x		03
napropamide	X			Yes	X		X	X		NC
s-metolachlor	X	X (or over top)			X		X	X		15
pendimethalin	X	X		(optional)	X		X	X		03
trifluralin	X	X		Yes	X		X	X		03
sulfentrazone	X				X			X	X	14
metribuzin	X	X	X	Yes PreTP	X	X	x	X	X	05
imazosulfuron	X	X	X		X	X		X	X	02
rimsulfuron	X		X		X	X		X	X	02
halosulfuron	X	X	X		X	X		X	X	02
clethodim			X			X	X			01
sethoxydim			X			X	X			01
carfentrazone	X	X				X		X	X	14
paraquat	X	X				X	X	X	X	22
glyphosate	X	X				X	X	X	X	09

Herbicide Injury

driftwatch.org



Tomato (Processing)

- Injury: dicamba = 2,4-D (Dintelmann et al.)*
- Yield loss: dicamba > 2,4-D (Jordan and Romanowski 1974)
- Epinasty, cupping, strapping.
- Flower drop and reduced fruit number.

*pepper injury far greater with dicamba than 2,4-D

Slide courtesy Stephen Meyers

Dicamba- 1 mo.

0 x | 1/10x | 1/3x | 1x

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Weller et al. (unpublished)

Slide courtesy Stephen Meyers

Pesticide Residue Limits

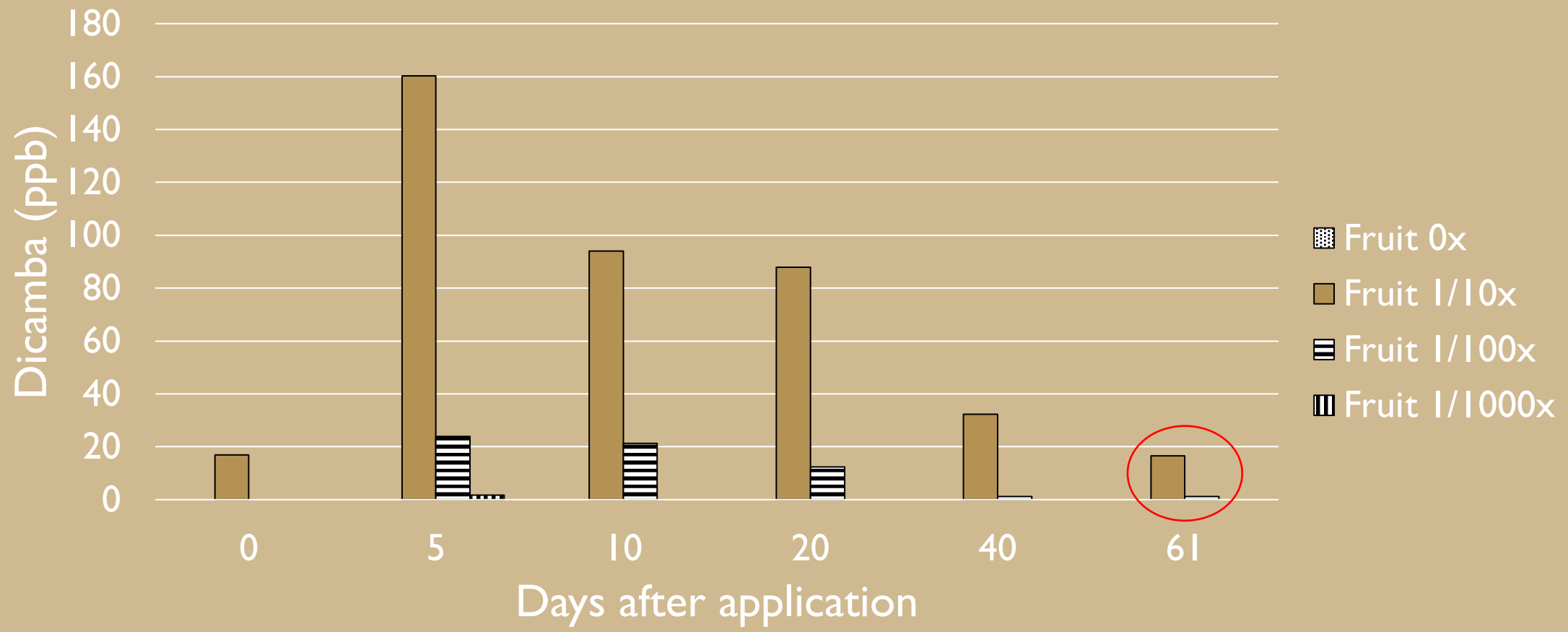
Herbicide and specific metabolites (ppm):

Crop	Dicamba*	2,4-D
Tomato	None	0.05
Cucurbits	None	0.05
Pome and stone fruits	None	0.05
Grape	None	0.05
Berries	None	0.20

*Only vegetable/fruit crops with dicamba tolerances: asparagus (4.0 ppm) and sweet corn (0.04 ppm).

Slide courtesy Stephen Meyers

Dicamba Residue in Tomato Fruit



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Slide courtesy Stephen Meyers

New Resources for Addressing Herbicide Drift

https://ipm-drift.cfaes.ohio-state.edu/dicamba-and-24-d-fact-sheet-series

Specialty Crops at Risk from Dicamba and 2,4-D Drift

North Central IPM Center

PART 1 OF 5

An Overview of Dicamba and 2,4-D Drift Issues

Dicamba and 2,4-D drift damage has captured national attention in recent years. Could your farm be at risk? And if so, what should you know to prevent, prepare, and respond? In this fact sheet—the first in a series—we explore how dicamba and 2,4-D drift has become a threat to specialty crop producers.

Changes in Dicamba and 2,4-D Use

Dicamba and 2,4-D are post-emergence herbicides that h
used for many decades to selectively control broadleaf w
corn, hay fields or pastures, small grains such as wheat,
They are also used to destroy existing broadleaf weeds p
planting agronomic crops.

Starting in 2016, the use of these herbicides changed. Ov
dependence on glyphosate has resulted in widespread gly
resistant broadleaf weeds. To improve management of th
weeds, new soybean varieties tolerant to over-the-top ap
of dicamba (Xtend soybean) or 2,4-D (Enlist soybean) w
commercialized in 2016 and 2019, respectively. Widespr
adoption of dicamba- and 2,4-D-resistant soybeans has l
use of these herbicides during the months of May, June,
(USDA 2019).

Dicamba and 2,4-D have been effective in controlling gly
resistant broadleaf weeds, but their expanded use has in
the risk of drift damage to high-value fruit and vegetable
landscape plants, and soybeans that do not carry the trai
dicamba or 2,4-D resistance. In addition to being more p
than glyphosate for many specialty crops, both herbicide
prone to drift. Off-target movements of dicamba, in partic
continues to be well documented in Missouri (Bradley 2
Illinois (Illinois DOA), and Indiana (Office of Indiana
Chemist 2019), despite efforts to reduce drift though in
formulations, training, and label restrictions.

Specialty Crops at Risk from Dicamba and 2,4-D Drift

PART 2 OF 5

Frequently Asked Questions

FIGURE 1 | Emerging grape leaves that received herbicide injury in the previous season continue to show damage early the next season.

*Dicamba and 2,4-D drift damage h
national attention in recent years.
farm be at risk? And if so, what sh
know to prevent, prepare, and resp
fact sheet, we look at some frequen
questions from specialty crop growe
still much for researchers to learn,
surrounding crop-specific and long-*

Are there times when plants are mor to drift damage?

Yes, but it varies greatly by plant. For example,
herbicide applications coincide with bud break a
in many woody and perennial plants–a time whe
highly susceptible to 2,4-D and dicamba drift. Fo
and fruit crops, yield is especially vulnerable dur
set. If harvested products could be tested for pes
processing or organic produce), drift damage clo
also be cause for increased concern.

Can damage last more than one seas

This is a question rich for further research. For w
other perennial species, the potential for long-term or accumulating effects is a concern. Herbicide drift may reduce winter hardiness and long-term vigor, which can result in high replacement costs and years of lost revenue waiting for new plants to produce. Research has also shown second generation damage from 2,4-D and dicamba exposure on some annual crops, including potatoes and soybeans. (Jones, et al., 2018; Geary, et al., 2019).

Does visible damage always mean lower yield?

The effects on yield depend on the crop species, growing stage and overall health, and the concentration of dicamba or 2,4-D in the drift plume. High concentrations of off-target dicamba or 2,4-D may lead to stunting or plant death with obvious effects on yield. But dramatic-looking injury may occur on highly sensitive species

Specialty Crops at Risk from Dicamba and 2,4-D Drift

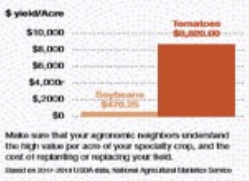
North Central IPM Center

PART 3 OF 5

Preparing for Drift Damage

Dicamba and 2,4-D drift damage has captured national attention in recent years. Could your farm be at risk? And if so, will you be ready to respond to a drift incident? In this fact sheet, we look at specific ways you can avoid, prevent, and prepare for drift damage.

Value per Acre, Soybeans vs. Tomatoes



Make sure that your agronomic neighbors understand the high value per acre of your specialty crop, and the cost of replanting or replacing your field.

Based on 2014–2018 USDA data, National Agricultural Statistics Service

Be Prepared

Evaluate your risk. Most fruit, vegetable, and ornamental crops are sensitive to 2,4-D and/or dicamba, but some are more sensitive than others. Are your crops known to be
damage? Are you located in a high-risk ar
example, an area dominated by corn and

Communicate with owners and operator
properties. A positive personal relationsh
will help. Explain the high sensitivity of y
drift, the high cost of production, and the
neighbors may be unaware that for most
there is no established residue tolerance
event may result in a complete loss of yo
not negatively impacted.

Make your crop known. Register for you
crop registry. This list is managed by Fiel
(driftwatch.org) or your state agricultura
applicators are required to check these re
You can also mark your property with sig
Fieldwatch/Driftwatch and other associat

Know the rules and regulations that go
You can look up specific product labels a
or Greenbook (greenbook.net). Label in
pesticide regulations, and applicators wh
can face fines or lose their applicator's lic
national label, your state pesticide regula
additional restrictions, such as cut-off da

Maintain financial and production reco
and fields. If a drift event occurs, good re
you to document financial losses for redu
quality, and the inability to recoup produc
yield data can be used to approximate yie
drift injury. Production budgets documen
and equipment depreciation will documer
financial losses.

Prepare a detailed farm map or maps,
features (wooded areas, wind breaks, buil
adjacent property). These maps can be a
damage occurred and where samples were
may be used as evidence for a loss claim,

Specialty Crops at Risk from Dicamba and 2,4-D Drift

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PART 4 OF 5

Responding to Drift Damage

Dicamba and 2,4-D drift damage has captured national attention in recent years. Could your farm be at risk? And if so, will you be ready to respond to a drift incident? In this fact sheet, we look at recommended actions for documenting damage, along with tips for seeking reparation or behavior change.

Responses to Drift Damage

- **Document observations, including plant damage, possible pesticide law infractions, and losses.**
- **Consult with crop and legal experts for advice, especially to rule out alternative causes.**
- **Contact neighboring businesses if you believe their activity may have caused drift damage.**
- **File a complaint with your state pesticide regulatory agency if you feel pesticide laws have been broken.**
- **Initiate legal action, if necessary, to recover losses.**

Document Observations Quickly

If you believe your plants have been damaged by herbicide drift, it is critical to **document your observations immediately, carefully, thoroughly, and repeatedly.** Growers affected by drift damage have important decisions to make on how they will respond, but all of these options hinge on documenting damage and related observations.

Spray Events

- Note the date and time of application, the name or a description of the applicator if possible, crops or conditions of the sprayed field (soybeans, fallow ground, etc.), along with any equipment you observed.
- Use photos, videos, and notes to document a possible infraction (spraying during high winds or after a state cut-off date, for instance).
- Document weather conditions for the spray event and the 3-5 days following application. (If the spray event was not observed, document weather for the week before drift damage was noticed).
  - Include temperature, wind direction and speed, and other conditions such as fog.
  - The National Weather Service maintains historical weather data for a variety of locations, but weather conditions could be different on your site. Use a local or personal weather station if possible.

Field Damage

Plant tissue damage caused by a drift event can be alarming. Remember that foliar damage does not always result in reduced yield or permanent damage, but **you will not get a second chance to collect photos and data.** Play it safe and document any damage (or questionable spraying events) as soon as you see it. Symptoms of 2,4-D and dicamba injury may appear within a few hours after contact with drift or within a few days. Severity and timing of injury depends on the concentration of drifted product, the transpiration rate of affected plants, and the relative sensitivity of the non-target crop.

- When documenting damage, include the date and the growth stage of affected plants. Use drawings, video, and photographs to record what you see.
- Record the development and progress of symptoms over time.
- Indicate the locations of observed symptoms using a reliable to-scale map of your farm and surrounding area. (If you don't

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Slide courtesy Stephen Meyers

Stewardship

- Growers participate in voluntary ISDA Stewardship and Conservation Program
- SYSCO Sustainable Ag Audit
  - Fertilizer and spray records
  - Tracking year to year usage of fertilizers and ag chemicals
  - Tracking any recycled items
  - Tracking water usage on irrigated fields.
  - Documentation of on-farm training of employees
  - Documentation of sprayer calibration
  - Participation in ag. training events
  - Document practices to reduce tillage, diesel use, trips in field, e.g. GPS
  - Plus more…

Image source: Sysco 2021 Corporate Social Responsibility Report www.sysco.com

THANK YOU

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