8 Carrot

Where: Grand Gallery C
MI Recertification Credits: 2 (1B, COMM CORE, PRIV CORE)
OH Recertification Credits: 0.5 (presentations as marked)
CCA Credits: NM (0.5) PM (1)
Moderator: Dan Brainard, Michigan State University

2:00 PM **Weed Control in a World Without Linuron (OH 2C, 0.5 hr)**
- Jed Colquhoun, University of Wisconsin

2:45 PM **Ontario Research: Carrot Nematicide Trials and Investigating Spray Coverage (OH 2B, 0.5 hr)**
- Dennis Van Dyk, Ontario Ministry of Agriculture, Food & Rural Affairs

3:15 PM **Carrot Industry Update**
- John Bakker, Michigan Carrot Industry Development Program

3:20 PM **Nematicide Trials in Michigan Carrots**
- Marisol Quintanilla-Tornel, Michigan State University

3:40 PM **Carrot Nitrate Management Update**
- Zachary Hayden, Michigan State University

4:00 PM **Session Ends**

Weed management without linuron in carrot

Jed Colquhoun, Rich Rittmeyer and Dan Heider
University of Wisconsin-Madison
Department of Horticulture

What's happening with linuron?

- US registration:
  - Linuron is currently in EPA registration review
    - Ecological and human health risk assessment
    - All other potential label changes on hold until then
  - Registrant is working on studies to determine linuron fate in soil and groundwater risk
- Global registrations:
  - European Commission declined to renew registration based on endocrine disruption risk
- Weed resistance becoming widespread, particularly among *Amaranthus* spp.

Lorox® DF
Agricultural Herbicide

APPLICATION DIRECTIONS

LOROX DF must be used in accordance with directions on this label. Injury to or loss of desirable trees or other plants may result from failure to observe the following application directions.

- **Do not apply by air.**
- **Do not apply to sand or loamy sand.**
- **Do not use on soils with less than 1% organic matter.**

Regardless of linuron, we need to think outside the box!

Weed Science

cambridge.org/wsc

Weed Management

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Key words:
Auxinic herbicides; growth regulator herbicides; gene stacking; six-way resistance

Author for correspondence:
Lovreet S. Shergill, Division of Plant Sciences, University of Missouri, Columbia, MO 65211. (Email: shergill@missouri.edu)

Investigations of 2,4-D and Multiple Herbicide Resistance in a Missouri Waterhemp (*Amaranthus tuberculatus*) Population

Lovreet S. Shergill[1], Blake R. Barlow[2], Mandy D. Bish[3] and Kevin W. Bradley[4]

[1]Postdoctoral Fellow, Division of Plant Sciences, University of Missouri, Columbia, MO, USA, [2]Graduate Research Assistant, Division of Plant Sciences, University of Missouri, Columbia, MO, USA, [3]Senior Research Specialist, Division of Plant Sciences, University of Missouri, Columbia, MO, USA and [4]Associate Professor, Division of Plant Sciences, University of Missouri, Columbia, MO, USA

Abstract

Research was conducted from 2015 to 2017 to investigate the potential for 2,4-D and multiple herbicide resistance in a waterhemp [*Amaranthus tuberculatus* (Moq.) J. D. Sauer] population from Missouri (designated MO-Ren). In the field, visual control of the MO-Ren population with 0.56 to 4.48 kg 2,4-D ha^{-1} ranged from 26% to 77% in 2015 and from 15% to 55% in 2016. The MO-Ren population was highly resistant to chlorimuron, with visual control never exceeding 7% either year. Estimates of the 2,4-D dose required to provide 50% visual control (I_{50}) of the MO-Ren population were 1.44 kg ha^{-1} compared with only 0.47 kg 2,4-D ha^{-1} for the susceptible population. Based on comparisons to a susceptible population in dose–response experiments, the MO-Ren population was approximately 3-fold resistant to 2,4-D, and 7-, 7-, 22-, and 14-fold resistant to atrazine, fomesafen, glyphosate, and mesotrione, respectively. Dicamba and glufosinate were the only two herbicides that provided effective control of the MO-Ren population in these experiments. Examinations of multiple herbicide resistance at the individual plant level revealed that 16% of the plants of the MO-Ren population contained genes stacked for six-way herbicide resistance, and only 1% of plants were classified as resistant to a single herbicide (glyphosate). Results from these experiments confirm that the MO-Ren *A. tuberculatus* population is resistant to 2,4-D, atrazine, chlorimuron, fomesafen, glyphosate, and mesotrione, making this population the third 2,4-D–resistant *A. tuberculatus* population identified in the United States, and the first population resistant to six different herbicidal modes of action.

Herbicide programs without linuron: loamy sand

Non-treated

Hand-weeded

Herbicide programs without linuron: loamy sand

Prowl H2O, Caparol, Caparol*

Dual Magnum, Caparol, Caparol*

* Caparol applied with 0.5% NIS. Dual Magnum available on Special Local Needs label in select states only.

Herbicide evaluation: muck

Program	Injury 6/16	Injury 7/1	Yield ton/A
Hand-weeded check	0	0	58
Prowl H2O PRE, Caparol 4 pt/A 3 lf, Caparol 4 pt/A 5 lf	50	50	38
Dual Magnum PRE, Caparol 4 pt/A 3 lf, Caparol 4 pt/A 5 lf	53	60	36
Prowl H20 PRE, Lorox 1.5 lb/A 3 lf, Lorox 1.5 lb/A 5 lf	0	0	56

Herbicide evaluation: muck

Program	Injury 6/14	Injury 6/29	Yield ton/A
Hand-weeded check	0	3	25
Prowl H2O PRE, Caparol 2 pt/A 3 lf, Caparol 2 pt/A 5 lf	16	12	21
Dual Magnum PRE, Caparol 2 pt/A 3 lf, Caparol 2 pt/A 5 lf	10	12	21
Prowl H20 PRE, Lorox 1.5 lb/A 3 lf, Lorox 1.5 lb/A 5 lf	0	0	13
Bicyclopyrone* 2.57 oz/A, Lorox 1.5 lb/A 3 lf, Lorox 1.5 lb/A 5 lf	0	0	12
Bicyclopyrone 3.42 oz/A, Lorox 1.5 lb/A 3 lf, Lorox 1.5 lb/A 5 lf	0	0	12
Bicyclopyrone 6.84 oz/A, Lorox 1.5 lb/A 3 lf, Lorox 1.5 lb/A 5 lf	0	0	14

* Bicyclopyrone is NOT labeled for use on carrot.

Herbicide evaluation: muck

Prowl H_20, Caparol, Caparol*

Dual Magnum, Caparol, Caparol*

* Caparol applied with 0.5% NIS.

Herbicide evaluation: muck

Prowl H_20, Lorox, Lorox

Bicyclopyrone*, Lorox, Lorox

* Bicyclopyrone is NOT labeled for use on carrot.

Caparol: field observations

- Compared to linuron:
  - More carrot injury potential
  - Takes longer for weeds to be controlled
- POST:
  - Excellent common lambsquarters control
  - Better redroot pigweed control on muck, by far, than Lorox (resistance likely)

Caparol: field observations

- POST: carrots with a leaf or less most susceptible
  - Use the correct surfactants and rates with POST applications
  - Be a bit patient on weed control
- Oat nurse crops:
  - PRE rates at 3.0 or 4.0 pt/a significantly reduce growth
  - Post applications at 2.0 pt/a may injure oats, but they recover

Field observations

2 pints/A Caparol PRE to carrots, POST to oats: oats silvered but recovered

Field observations

2 pints/A Caparol POST: use the labeled adjuvants!

Carrot cultivar competitiveness

Spring M.

SFF

Carrot cultivar competitiveness

Spring M.

SFF

Can gibberellic acid increase competitiveness?

Influence of Gibberellic Acid on Carrot Growth and Severity of Alternaria Leaf Blight

P. Santos, Graduate Student, Department of Plant Pathology, University of California, Davis 95616; **J. J. Nunez,** University of California Cooperative Extension, Kern County 93307; and **R. M. Davis,** Cooperative Extension Specialist, Department of Plant Pathology, University of California, Davis 95616

ABSTRACT

Santos, P., Nunez, J. J., and Davis, R. M. 2000. Influence of gibberellic acid on carrot growth and severity of Alternaria leaf blight. Plant Dis. 84:555-558.

Applications of gibberellic acid (GA) to carrot foliage consistently reduced the percentage of leaf area affected by *Alternaria dauci* compared with nontreated plants. The degree of leaf blight reduction with two applications of GA was similar to that achieved with four applications of the fungicide iprodione. At the rates examined (GA at 2.5 to 250 mg/liter), foliage dry weights were generally increased by GA. Although root weight was significantly reduced by rates of 250 mg/liter, applications of lower rates (40 mg/liter or less) reduced leaf blight severity without affecting root quality. Applications of GA usually resulted in plants with longer leaves, wider petioles, and a more upright growth habit. In one trial, leaf length and petiole diameter increased linearly with increasing rates (20, 30, and 40 mg/liter). When applied twice at 30 mg/liter, GA did not affect cuticle, epidermal, or leaf thickness. In general, the initial timing of two applications of 20 to 40 mg/liter (4, 6, or 8 weeks after plant emergence) did not influence the effects of GA. However, in one trial, there was a greater incidence of core separation from the root cortex when 40 mg/liter was applied initially at 4 weeks. GA at 30 mg/liter slightly but significantly decreased inner root color in one of two trials.

Prior to harvesting, a minimum of 12 carrots in each plot was evaluated for leaf blight severity on a scale of 0 to 5, indicating 0, 1, 5, 10, 20, and 40% or more, respectively, of the total leaf area blighted. Each value represented the incremental midpoint on the severity scale (14). Shoot length, petiole diameter, top dry weight, and root dry weight of 12 carrots arbitrarily selected from each plot were measured at the time of harvest (12 to 14 weeks after plant emergence). Shoot length and petiole diameter measurements were made on the two youngest fully expanded leaves. Measurements of petiole diameters were made 10 cm from the base of the leaf.

The effect of GA on carrot root color, core separation, and leaf morphology was determined in the latter two trials. Inner and outer root color were measured using a

- Known to increase top growth, but at some concentrations and times at the cost of root growth

Can gibberellic acid increase competitiveness?

ProGibb® 4%
PLANT GROWTH REGULATOR
SOLUTION

For Agricultural Use
For Organic Production

ACTIVE INGREDIENT: Gibberellic Acid	4.0% w/w
OTHER INGREDIENTS	96.0% w/w
TOTAL	100.0% w/w

ProGibb 4% liquid contains approximately 1.0 gram active ingredient p
fluid ounce of formulated product.

EPA Reg. No. 73049-15
EPA Est. No. 33762-IA-001 List No. 05016

Carrots, Fresh and Processing	To delay leaf senescence. Maintaining vigorous foliage has been shown to help reduce the incidence of infection by *Alternaria dauci.*	1-6	Make the first application 4-6 weeks after emergence using commercial ground or aerial equipment with spray concentrations of 20-30 ppm. In severe disease situations or cool weather a second spray 14 days later is sometimes required to achieve the desired amount of foliar recovery. Do not apply more than twice per crop.

NOTE:
• Dilutions of greater concentration can increase the risk of excessive top growth, particularly with a second application.

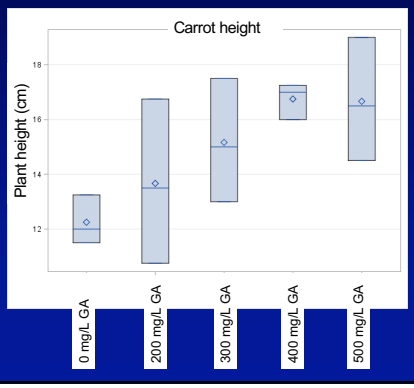
Can gibberellic acid increase competitiveness?

- Preliminary study in 2017
- 3 varieties: 'Canada', 'Carson' and 'Enterprise'
- 4 gibberellic acid application rates
  - 200, 300, 400 and 500 mg/L/season
  - Split across 2 applications at 3- and 5-leaf carrots
  - Tank mixed with Caparol + NIS (0.5% v/v)

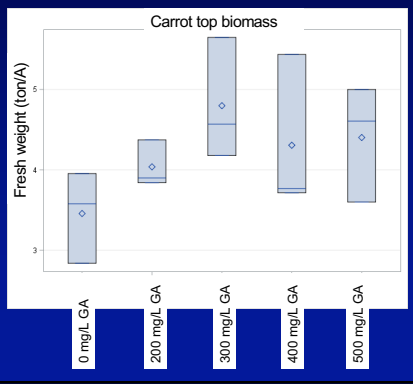
Can gibberellic acid increase competitiveness?

- Measured on a weekly basis:
  - Crop injury
  - Carrot top height
  - Carrot canopy cover
  - All weeds were controlled with herbicides (Prowl H2O was used PRE)
- Measured at harvest:
  - Carrot top fresh weight
  - Carrot root weight
  - Carrot root number

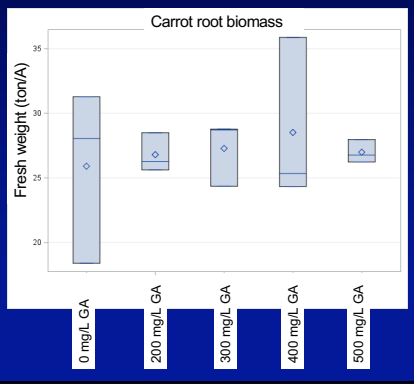
Can gibberellic acid increase competitiveness?



Can gibberellic acid increase competitiveness?



Can gibberellic acid increase competitiveness?



Can gibberellic acid increase competitiveness?

O mg/L GA

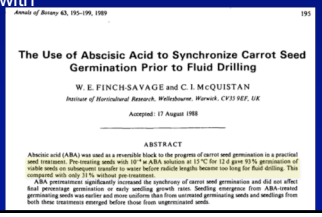
400 mg/L GA

With no new herbicides in sight, it's time to really think out of the box…

- Putting together a systematic approach:
  - Competitive cultivars with foliar disease resistance

With no new herbicides in sight, it's time to really think out of the box…

- Putting together a systematic approach:
  - Competitive cultivars with foliar disease resistance
  - Rapid emergence with seed germinators



Annals of Botany 63, 195–199, 1989 195

The Use of Abscisic Acid to Synchronize Carrot Seed Germination Prior to Fluid Drilling

W. E. FINCH-SAVAGE and C. J. McQUISTAN
Institute of Horticultural Research, Wellesbourne, Warwick, CV35 9EF, UK

Accepted: 17 August 1988

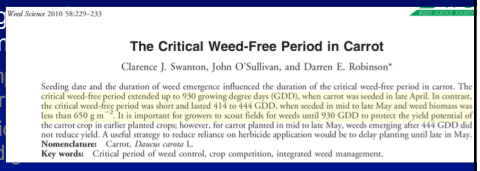
ABSTRACT

Abscisic acid (ABA) was used as a reversible block to the progress of carrot seed germination in a practical seed treatment. Pre-treating seeds with 10^{-4} M ABA solution at 15 °C for 12 d gave 93% germination of viable seeds on subsequent transfer to water before radicle length became too long for fluid drilling. This compared with only 31% without pre-treatment.

ABA pretreatment significantly increased the synchrony of carrot seed germination and did not affect final percentage germination or early seedling growth rates. Seedling emergence from ABA-treated germinating seeds was earlier and more uniform than from untreated germinating seeds and seedlings from both these treatments emerged before those from ungerminated seeds.

With no new herbicides in sight, it's time to really think out of the box…

- Putting together a systematic approach:
  - Competitive cultivars with foliar disease resistance
  - Rapid emergence with seed germinators
  - Later planting dates when flexible and yielding



Weed Science 2010 58:229–233

The Critical Weed-Free Period in Carrot

Clarence J. Swanton, John O'Sullivan, and Darren E. Robinson*

Seeding date and the duration of weed emergence influenced the duration of the critical weed-free period in carrot. The critical weed-free period extended up to 930 growing degree days (GDD), when carrot was seeded in late April. In contrast, the critical weed-free period was short and lasted 414 to 444 GDD, when seeded in mid to late May and weed biomass was less than 650 g m^{-2}. It is important for growers to scout fields for weeds until 930 GDD to protect the yield potential of the carrot crop in earlier planted crops; however, for carrot planted in mid to late May, weeds emerging after 444 GDD did not reduce yield. A useful strategy to reduce reliance on herbicide application would be to delay planting until late in May.

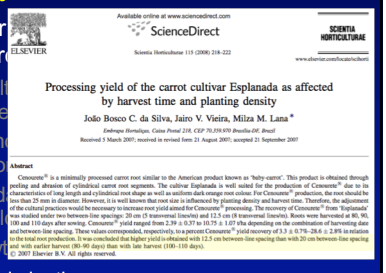
Nomenclature: Carrot, *Daucus carota* L.
Key words: Critical period of weed control, crop competition, integrated weed management.

With no new herbicides in sight, it's time to really think out of the box…

- Putting together a systematic approach:
  - Competitive cultivars with foliar disease resistance
  - Rapid emergence with seed germinators
  - Later planting dates when flexible and yielding
  - Rapid top growth with GA

With no new herbicides in sight, it's time to really think out of the box…

- Putting together a systematic appr
  - Competitive cul foliar disease re
  - Rapid emergen seed germinato
  - Later planting d flexible and yiel
  - Rapid top grow
  - Competitive bed plantings



Available online at www.sciencedirect.com
ScienceDirect
Scientia Horticulturae 115 (2008) 218–222
SCIENTIA HORTICULTURAE
ELSEVIER

Processing yield of the carrot cultivar Esplanada as affected by harvest time and planting density

João Bosco C. da Silva, Jairo V. Vieira, Milza M. Lana *
Embrapa Hortaliças, Caixa Postal 218, CEP 70,359-970 Brasília-DF, Brazil

Received 5 March 2007; received in revised form 21 August 2007; accepted 21 September 2007

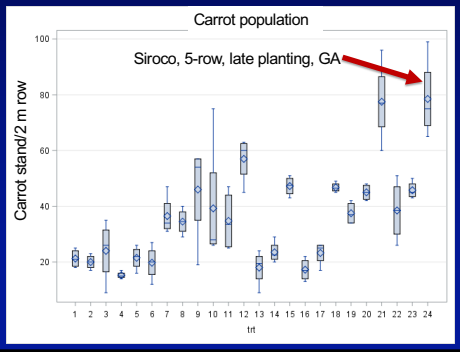
Abstract

Cenoura® is a minimally processed carrot root similar to the American product known as 'baby-carrot'. This product is obtained through peeling and abrasion of cylindrical carrot root segments. The cultivar Esplanada is well suited for the production of Cenoura® due to its characteristics of long length and cylindrical root shape as well as uniform dark orange root colour. For Cenoura® production, the root should be less than 25 mm in diameter. However, it is well known that root size is influenced by planting density and harvest time. Therefore, the adjustment of the cultural practices would be necessary to increase root yield aimed for Cenoura® processing. The recovery of Cenoura® from 'Esplanada' was studied under two between-line spacings: 20 cm (5 transversal lines/m) and 12.5 cm (8 transversal lines/m). Roots were harvested at 80, 90, 100 and 110 days after sowing. Cenoura® yield ranged from 2.39 ± 0.37 to 10.75 ± 1.07 t/ha depending on the combination of harvesting date and between-line spacing. These values corresponded, respectively, to a percent Cenoura® yield recovery of 3.3 ± 0.7%–28.6 ± 2.8% in relation to the total root production. It was concluded that higher yield is obtained with 12.5 cm between-line spacing than with 20 cm between-line spacing and with earlier harvest (80–90 days) than with late harvest (100–110 days).

With no new herbicides in sight, it's time to really think out of the box…

- 2018 field research:
  - 3 carrot varieties with varying competitive ability
  - 2 planting dates (late-April and mid-May)
  - 2 row spacings/seeding densities
  - With and without plant hormone stimulants

Putting it all together, what worked best?



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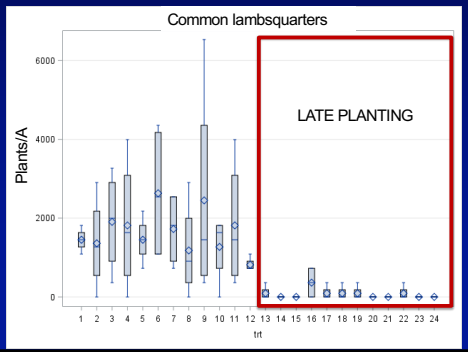

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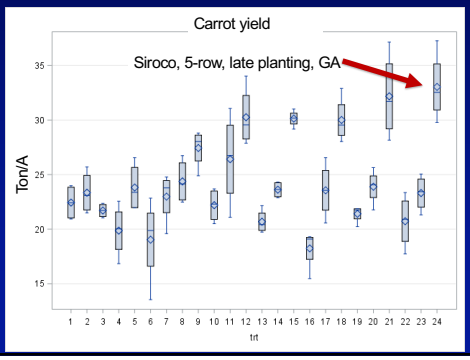

Carrot varieties

3-row vs. 5-row

Current state vs. integrated system

2018 research observations

- Weed pressure greatly reduced by delaying planting by 2 weeks
- Gibberellic acid not only enhanced top growth but also hastened recovery from Caparol stunting
- Canopy closure observed much earlier in growing season where carrot seeded in 5 rows vs. 3 rows
- Foliar disease resistance will be important