**OPVC FINAL PROJECT REPORT:** *2016* **PROJECT YEAR**: *1 of 1*

## 1. OPVC REPORT COVER PAGE (maximum 2 pages)

**Project Title**: *Tolerance of Carrots to Bicyclopyrone and Tolpyralate, 2016*


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**Total Project Request (all years):**
**Year 1:** 5,280 **Year 2:** **Year 3:**

**Other funding sources:** none

## 2. EXECUTIVE SUMMARY (ABSTRACT):


Experiments in Corvallis, OR and Pasco, WA evaluated the potential of bicyclopyrone, tolpyralate, halosulfuron and EPTC for weed control in carrots. Bicyclopyrone and tolpyralate significantly reduced plant stand, injured carrots, and reduced yield at all three rates. Only bicyclopyrone at 0.875 oz/A and tolpyralate at 1 oz/A provided yield within range of linuron, prometryn, and EPTC treatments. The prometryn treatment yielded the most carrots, followed closely by linuron and EPTC. Halosulfuron killed all carrots. Weed control with bicyclopyrone and tolpyralate was similar when comparing within treatments with equal carrot injury. A possible exception was that tolpyralate may have controlled crabgrass better than bicyclopyrone. Prometryn control of hairy nightshade lasted longer than linuron.

## 3. **FULL REPORT**

### 3a. BACKGROUND

Tolpyralate and bicyclopyrone are two herbicides with potential use for weed control in carrots grown for processing in Oregon. Tolpyralate is manufactured by ISK and distributed by Summit Ag. Bicyclopyrone is in the premix of Acuron (Syngenta) labeled for corn, but there are no other registrations for bicyclopyrone in other crops at this time. Observations from a screening trial in fresh market vegetables in 2015 indicated potential for both of these products to make important contributions to weed control in the future. IR-4 prioritized this project in September, 2015 and magnitude of residue and efficacy studies were carried out across the US this summer.

### 3.b OBJECTIVES

The primary objective of this study was to demonstrate carrot crop safety and efficacy of bicyclopyrone and tolpyralate in Oregon and Columbia Basin conditions when applied to carrots for weed control. Secondary objectives were to evaluate potential use of Eptam in carrots.

### 3.c METHODS

*Corvallis*

The trial was located in Corvallis at the Vegetable Research Farm. Carrots (var. Nelson) were planted on **8-Jun** at 420,000 seeds/A on 26 inch rows. Bicyclopyrone was applied both PRE and POST (2-3 leaf carrots) at 0.875, 1.75, and 3.5 oz/A. Tolpyralate was applied PRE and POST at 1/2, 1 and 2 oz/A (Table 1). Starter fertilizer (200 lbs/A of 12-10-10) was banded next to the row after seedlings had emerged on **23-Jun**. Urea (50 lb N/A) was banded between rows on **15-Jul.** Lorox was applied to the entire trial 10 days after the EPOST application to suppress/control weeds and reduce weed competition with the carrot crop. Treatments were replicated 4 times in a randomized complete block design. Carrots were harvested from 10 ft of row on **26-Aug.** Roots from the replications for each treatment were composited into one sample before they were sent to a commercial facility in Pasco, WA for grading.

*Pasco*

Beds were formed with hilling shovels and a press wheel that were 10 inches tall and 44 inches from the center of one bed to the adjacent bed. Carrot (cv. Uppercut), were planted on 2-Jun**, 2016** with a cone type seeder at a population of 750,000 seeds per acre at a depth of ¼ inch. Each plot was 44 inches wide and 20 feet long with four replications of each treatment in a randomized complete block design. The soil texture was a Quincy Loamy Fine Sand series.

Post plant pre-emergent applications (PRE) were made on **3-Jun, 2016** with a CO2 backpack sprayer at an application rate of 20 gallons of water per acre. The sprayer boom had two 11002 XR flat fan nozzles and the pressure was set to 25 psi. The temperature in the morning of the 3rd was 56.4 degrees Fahrenheit. The relative humidity was 25% with wind speeds of 3.7 mph from the northeastern direction. The second application was made at the 2-3 leaf stage on **24-June** with the same spray equipment as above. The temperature on the morning of the 24th was 56.9 degrees Fahrenheit. The relative humidity was 22% with wind speeds up to 8.4 mph coming from the west. Chemigation applications were also made using a system that mimics application via center pivot chemigation (CHEM1 and 2 applied **3 and 4-Jun**, respectively). Those applications were made with 2,700 gallons of water per acre.

Efficacy and crop safety data were taken on **22 and 29-Jun** by evaluating the damage to the crop and the percentage of the plot with adequate weed control. Weed species present included Russian thistle (*Salsola kali*), puncture vine (*Tribulus terrestris*), redroot pigweed (Amaranthus retroflexus), and lambsquarters (Chenopodium album). Yield was evaluated by harvesting a 5 ft. section of each plot on **15-Sept** and sent to a commercial facility for grading.

**3.d RESULTS & DISCUSSION**

*Corvallis (Tables 1 to 5 below)*

Bicyclopyrone and tolpyralate significantly reduced plant stand, injured carrots, and reduced yield at all three rates in this trial. Only bicyclopyrone at 0.875 oz/A and tolpyralate at 1 oz/A provided yield within range of linuron, prometryn, and EPTC treatments. The prometryn treatment yielded the most carrots, followed closely by Lorox and Eptam. Halosulfuron reduced carrot yield to near 0.

The predominant weed species present was hairy nightshade (*Solanum sarrachoides/ physafolium*), with a few pigweed (*Amaranthus retroflexus*), lambsquarters (*Chenopodium album*), and common purslane (*Portulaca oleracea*) interspersed. Crabgrass (*Digitaria sanguinalis*) emerged later than the other weeds and data is only presented at the 2$^{nd}$ rating. Weed control with bicyclopyrone and tolpyralate was similar when comparing within treatments with equal carrot injury. A possible exception was that tolpyralate may have controlled crabgrass better than bicyclopyrone. Prometryn (Caparol) control of hairy nightshade lasted longer than linuron.

*Pasco (Tables 6 and 7)*

After the initial application, the only treatment that significantly improved weed control compared to the untreated check was the 1 oz per acre rate of halosulfuron (Sandea). All other treated plots reduced weed pressure, but not at a level that was statistically significant. The plots treated with halosulfuron at 1 oz/A and tolpyralate at 1 and 2 oz/A also had significant levels of crop damage compared to the untreated check.

After the second application date, crop safety and efficacy was evaluated again. The only treatments that exhibited efficacy significantly better than the untreated check and crop safety that was significantly better than the untreated check was linuron (Lorox) 1 lb/A, prometryn (Caparol) 2 pt/A and the tank mix of linuron 1 lb/A and EPTC (Eptam) at 3.5 pint/A as pre-emergent applications. Many treatments offered improved weed control, but caused significant crop damage.

Bicyclopyrone (1.75 and 3.5 oz/A), and tolpyralate (1and 2oz/A rates) showed the most significant decline in yield (tons/Acre) compared to the untreated check. The preemergent application of Sandea killed most of the carrots in the plots and therefore there was no crop yield from those treatments.

**Table** 1. Site description and journal of activities, Corvallis.

| | |
|---|---|
| **TRIAL LOCATION** | |
| City | Corvallis |
| State/Prov | OR |
| Trial Reliability | Good |
| **CROP DESCRIPTION** | |
| Crop | Carrots |
| Planting Date | 8-Jun |
| Row spacing | 26 in |
| Seed Bed | Small clods |
| Variety | Nelson (Bejo Seeds) |
| Planting Method | Gaspardo vacuum seeder |
| Depth | ½ to 3/4 in |
| Spacing Within Row | 0.58 in/seed (21/ft) |
| **SITE AND DESIGN** | |
| Previous crop | Sweet corn |
| Plot Width | 6.5 spray width, 9 foot plots |
| Plot Length | 20 |
| Reps | 4 |
| Tillage Type | Conv |
| Study Design | RCBD |
| **SOIL DESCRIPTION** | |
| Soil type | Chehalis silt loam |
| Location | Lat 44.5727; Lon: -123.2417 |
| % OM 2.30; pH 7.1; CEC 21.75 | |

| **JOURNAL** | |
|---|---|
| Tuesday, June 7, 2016 | Eptam applied then final tillage |
| Wednesday, June 8, 2016 | Planted 1/2 to 3/4 deep into cloddy soil, 21 seeds per foot |
| Thursday, June 9, 2016 | Applied PRE herbicides |
| Friday, June 10, 2016 | Irrigation 0.5 inch |
| Thursday, June 23, 2016 | Starter fertilizer banded next to row, 200 lbs 12-10-10/A<br>Followed by irrigation |
| Thursday, June 30, 2016 | Weed evaluation |
| Wednesday, July 6, 2016 | EPOST<br>Additional 50 lbs N (urea) fertilizer applied between rows |
| Thursday, July 7, 2016 | 3 hrs irrigation |
| Saturday, July 11, 2016 | Plots cultivated between rows |
| Saturday, July 16, 2016 | Eval scheduled for 2 WAT, but could not wait; weeds getting too big, needed to apply Lorox |
| Saturday, July 16, 2016 | Applied Lorox to entire plot |
| Tuesday, July 26, 2016 | Crop safety evaluation |
| Friday, August 26, 2016 | Harvest from 10 ft of center row |

**Table 2.** Herbicide application data for Corvallis.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Date | June 7, 2016 | June 9, 2016 | July 6, 2016 | July 16, 2016 |
| Crop stage | - | After planting | All 2 lf, a few 3 leaf | Very small roots, plants up to 18 in tall |
| Weeds and growth stage | | | | |
| Predominately HNS | - | - | <4 in. tall | - |
| Herbicide/treatment | Eptam | 2,3,4,8,9,10, 14,15, 17, 18 | 5,6,7,11,12,13 | Lorox applied to entire plot 10 DA EPOST |
| Application timing | PPI | PRE | EPOST | EPOST LOROX |
| Start/end time | 7:00 AM | 8:30 to 9:15 PM | 6-6:40 AM | 7-7:30 AM |
| Air temp/soil temp (2")/surface | 63/63/ | 57/60 | 63/62/62 | 66/ |
| Rel humidity | 56% | 82% | 83% | 67% |
| Wind velocity (mph) | 0-1 | 1-5 | 0 | 0 |
| Cloud cover | 50% | 100% | 0 | 100% |
| Soil moisture | Very dry | Very dry | Dry | Very dry |
| Plant moisture | _ | _ | Dew | Dew |
| Sprayer/PSI | BP 30 PSI | BP 30 PSI | BP 30 PSI | BP 30 PSI |
| Mix size | 2100 mls 4 plots | 2100 | 2100 | 3 gal |
| Gallons H20/acre | 20 | 20 | 20 | 20 |
| Nozzle type | 5XR-8003 | 5XR-8003 | 5XR-8003 | 5-XR8003 |
| Nozzle spacing and height | 20/24 | 20/24 | 20/24 | 20/24 |
| Soil inc. method/implement | Incorporated within 15 minutes with Rotera | Irrigated ~ ½ in. on 10-Jun | - | Irrigation 7 hours later |

**Table 3.** Carrot seedling emergence and weed control before EPOST applications, Corvallis.

| | Treatment | Rate | | | Timing | Emergence | Phyto | Stunting | Weed control 30-Jun | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Hairy nightshade | Pigweed | Common lambsquarters | Common purslane | Composite rating |
| | | *product* | | *lb ai/A* | | *no./4 ft* | *bleaching (0-10)* | ----------%---------- | | | | | |
| 1 | Untreated | - | | - | - | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Bicyclopyrone | 0.875 | oz/A | 0.011 | PRE | 21 | 2.0 | 48 | 89 | 88 | 88 | 88 | 91 |
| 3 | Bicyclopyrone | 1.75 | oz/A | 0.023 | PRE | 5 | -[a] | 100 | 100 | 100 | 100 | 100 | 100 |
| 4 | Bicyclopyrone | 3.5 | oz/A | 0.046 | PRE | 2 | - | 100 | 78 | 100 | 100 | 100 | 100 |
| 5 | Bicyclopyrone | 0.875 | oz/A | 0.011 | 2-3 Lf | - | - | - | 0 | 0 | 0 | 0 | 0 |
| 6 | Bicyclopyrone | 1.75 | oz/A | 0.023 | 2-3 Lf | - | - | - | 0 | 0 | 0 | 0 | 0 |
| 7 | Bicyclopyrone | 3.5 | oz/A | 0.046 | 2-3 Lf | - | - | - | 0 | 0 | 0 | 0 | 0 |
| 8 | Tolpyralate | 0.5 | oz/A | 0.013 | PRE | 18 | 1.3 | 18 | 61 | 88 | 100 | 75 | 68 |
| 9 | Tolpyralate | 1 | oz/A | 0.026 | PRE | 14 | 2.0 | 58 | 60 | 53 | 75 | 75 | 65 |
| 10 | Tolpyralate | 2 | oz/A | 0.052 | PRE | 4 | - | 98 | 98 | 100 | 100 | 78 | 99 |
| 11 | Tolpyralate | 0.5 | oz/A | 0.013 | 2-3 Lf | - | - | - | 0 | 0 | 0 | 0 | 0 |
| 12 | Tolpyralate | 1 | oz/A | 0.026 | 2-3 Lf | - | - | - | 0 | 0 | 0 | 0 | 0 |
| 13 | Tolpyralate | 2 | oz/A | 0.052 | 2-3 Lf | - | - | - | 0 | 0 | 0 | 0 | 0 |
| 14 | Linuron | 1 | lbs/A | 0.5 | PRE | 30 | 0 | 0 | 98 | 100 | 100 | 100 | 99 |
| 15 | Prometryn | 2 | pt/A | 1.0 | PRE | 36 | 0 | 0 | 100 | 100 | 78 | 100 | 100 |
| 16 | EPTC | 3.5 | pt/A | 3.1 | PPI | 31 | 0 | 3 | 97 | 100 | 100 | 100 | 98 |
| 17 | Halosulfuron | 1.00 | oz/A | 0.047 | PRE | 20 | 5.3 | 63 | 60 | 100 | 100 | 100 | 73 |
| 18 | S-metolachlor + Bicyclopyrone + NIS 0.25% | 10.66<br>0.875 | oz/A<br>oz/A | 0.63<br>0.011 | PRE<br>2-3 Lf | 26 | 0 | 20 | 95 | 98 | 75 | 100 | 97 |
| | FPLSD (0.05) | | | | | 11 | 1.5 | 19 | 26 | 22 | 30 | 30 | 19 |

[a] No plants survived the treatment and phytotoxicity ratings were not possible.

**Table 4.** Crop safety and weed control in carrots 16-Jul, 2016, Corvallis.

| | Treatment | Rate | | | Timing | Phyto | Stunting | Weed control 16-Jul | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Hairy nightshade | Pigweed | Lambs-quarters | Common purslane | Crab-grass | Composite rating |
| | | *product* | | *lb ai/A* | | *bleaching 0-10* | | % | | | | | |
| 1 | Untreated | - | | - | - | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Bicyclopyrone | 0.875 | oz/A | 0.011 | PRE | 0 | 95 | 73 | 97 | 100 | 63 | 50 | 80 |
| 3 | Bicyclopyrone | 1.75 | oz/A | 0.023 | PRE | -[a] | 100 | 95 | 100 | 100 | 100 | 100 | 98 |
| 4 | Bicyclopyrone | 3.5 | oz/A | 0.046 | PRE | - | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 5 | Bicyclopyrone | 0.875 | oz/A | 0.011 | 2-3 Lf | 4.0 | 13 | 50 | 55 | 0 | 0 | 0 | 35 |
| 6 | Bicyclopyrone | 1.75 | oz/A | 0.023 | 2-3 Lf | 4.5 | 30 | 58 | 75 | 48 | 13 | 60 | 68 |
| 7 | Bicyclopyrone | 3.5 | oz/A | 0.046 | 2-3 Lf | 5.5 | 45 | 65 | 63 | 17 | 60 | 50 | 58 |
| 8 | Tolpyralate | 0.5 | oz/A | 0.013 | PRE | 0 | 13 | 40 | 97 | 100 | 85 | 100 | 48 |
| 9 | Tolpyralate | 1 | oz/A | 0.026 | PRE | 0 | 43 | 45 | 100 | 100 | 100 | 100 | 50 |
| 10 | Tolpyralate | 2 | oz/A | 0.052 | PRE | 0 | 100 | 89 | 100 | 100 | 100 | 98 | 92 |
| 11 | Tolpyralate | 0.5 | oz/A | 0.013 | 2-3 Lf | 2.8 | 13 | 23 | 70 | 25 | 0 | 50 | 30 |
| 12 | Tolpyralate | 1 | oz/A | 0.026 | 2-3 Lf | 3.3 | 28 | 43 | 75 | 75 | 10 | 40 | 43 |
| 13 | Tolpyralate | 2 | oz/A | 0.052 | 2-3 Lf | 4.5 | 50 | 56 | 83 | 33 | 17 | 50 | 56 |
| 14 | Linuron | 1 | lbs/A | 0.5 | PRE | 0 | 0 | 76 | 100 | 100 | 100 | 75 | 83 |
| 15 | Prometryn | 2 | pt/A | 1.0 | PRE | 0 | 0 | 99 | 100 | 75 | 100 | 100 | 99 |
| 16 | EPTC | 3.5 | pt/A | 3.1 | PPI | 0 | 0 | 89 | 100 | 63 | 82 | 100 | 90 |
| 17 | Halosulfuron | 1.00 | oz/A | 0.047 | PRE | - | 100 | 33 | 100 | 100 | 100 | 100 | 53 |
| 18 | S-metolachlor + Bicyclopyrone + NIS 0.25% | 10.66<br>0.875 | oz/A<br>oz/A | 0.63<br>0.011 | PRE<br>2-3 Lf | 5.8 | 50 | 98 | 100 | 85 | 100 | 100 | 98 |
| | FPLSD(0.05) | | | | | 0.9 | 16 | 27 | 33 | 56 | 32 | 54 | 26 |

[a] No plants survived the treatment and phytotoxicity ratings were not possible.

**Table 5.** Crop safety (26-Jul) and carrot root yield (26-Aug), Corvallis.

| | Treatment | Rate | | Timing | Crop injury 26-Jul | | Carrot yield and grades 26-Aug, 2016 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Phyto | Stunting | Roots | Clean root yield | Avg. root wt, | < 5/ in dia | 5/8 to 1 5/8 in dia. | <2 in long | Mis-shaped | Cracked | Composite weed control at harvest |
| | | *product* | *lb ai/A* | | *bleaching 0-10* | *%* | *no./A* | *t/A* | *g* | ---------- *%* ---------- | | | | | |
| 1 | Untreated | - - | - | - | 0 | 25 | 80000 | 1.6 | 19 | 15 | 81 | 0 | 0 | 3 | 0 |
| 2 | Bicyclopyrone | 0.875 oz/A | 0.011 | PRE | 2 | 89 | 1500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 44 |
| 3 | Bicyclopyrone | 1.75 oz/A | 0.023 | PRE | - [a] | 100 | 1500 | 0.1 | 18 | 0 | 0 | 0 | 0 | 0 | 98 |
| 4 | Bicyclopyrone | 3.5 oz/A | 0.046 | PRE | - | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| 5 | Bicyclopyrone | 0.875 oz/A | 0.011 | 2-3 Lf | 3 | 23 | 181000 | 9.7 | 48 | 1 | 95 | 1 | 1 | 3 | 60 |
| 6 | Bicyclopyrone | 1.75 oz/A | 0.023 | 2-3 Lf | 3 | 35 | 132000 | 6.9 | 50 | 1 | 94 | 1 | 1 | 2 | 83 |
| 7 | Bicyclopyrone | 3.5 oz/A | 0.046 | 2-3 Lf | 5 | 40 | 95000 | 4.0 | 28 | 3 | 92 | 1 | 0 | 4 | 96 |
| 8 | Tolpyralate | 0.5 oz/A | 0.013 | PRE | 0 | 20 | 59000 | 3.3 | 41 | 1 | 87 | 0 | 1 | 9 | 24 |
| 9 | Tolpyralate | 1 oz/A | 0.026 | PRE | 0 | 43 | 25000 | 1.5 | 51 | 2 | 93 | 0 | 0 | 5 | 41 |
| 10 | Tolpyralate | 2 oz/A | 0.052 | PRE | 0 | 99 | 2000 | 0.1 | 14 | 13 | 87 | 0 | 0 | 0 | 93 |
| 11 | Tolpyralate | 0.5 oz/A | 0.013 | 2-3 Lf | 2 | 18 | 109000 | 3.1 | 25 | 5 | 88 | 2 | 0 | 3 | 40 |
| 12 | Tolpyralate | 1 oz/A | 0.026 | 2-3 Lf | 2 | 35 | 161000 | 8.3 | 47 | 1 | 93 | 2 | 1 | 3 | 73 |
| 13 | Tolpyralate | 2 oz/A | 0.052 | 2-3 Lf | 5 | 65 | 108000 | 4.3 | 37 | 5 | 91 | 1 | 1 | 2 | 78 |
| 14 | Linuron | 1 lbs/A | 0.5 | PRE | 0 | 0 | 158000 | 13.0 | 76 | 0 | 91 | 1 | 1 | 6 | 78 |
| 15 | Prometryn | 2 pt/A | 1.0 | PRE | 0 | 0 | 178000 | 14.8 | 76 | 0 | 92 | 2 | 1 | 4 | 95 |
| 16 | EPTC | 3.5 pt/A | 3.1 | PPI | 0 | 3 | 151000 | 11.9 | 74 | 0 | 94 | 1 | 1 | 4 | 90 |
| 17 | Halosulfuron | 1.0 oz/A | 0.047 | PRE | - | 100 | 17000 | 0.4 | 7 | 0 | 70 | 0 | 0 | 0 | 30 |
| 18 | S-metolachlor + Bicyclopyrone + NIS 0.25% | 10.66 oz/A<br>0.875 oz/A | 0.63<br>0.011 | PRE<br>2-3 Lf | 5 | 63 | 108000 | 6.1 | 51 | 1 | 94 | 1 | 1 | 3 | 100 |
| | FPLSD (0.05) | | | | 2.0 | 26 | 51200 | 2.9 | 24 | - [b] | - | - | - | - | 36 |

[a] No plants survived the treatment and phytotoxicity ratings were not possible.

[b] One observation for each treatment because roots from replicated plots were composited into one sample to facilitate grading.

**Table 6.** Crop safety and weed control for carrots planted on 2-Jun. PRE and CHEM1 (chemigation) treatments applied on 3-Jun; 2-3 lf and CHEM2 (chemigation) treatments applied on 24-Jun, Pasco, WA.

| | Treatment | Rate | | Timing | 22-Jun | | 28-Jun | 29-Jun | | | 28-July |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Weed control | Crop injury | Carrot stand | Carrot ht. | Carrot phyto rating | Weed control | Carrot ht. |
| | | *product* | *lb ai/A* | | *%* | *%* | *no./* | *cm* | *%* | *%* | *cm* |
| 1 | Untreated | - | - | - | 49 | 0.6 | 240 | 9.8 | 0 | 29 | 44 |
| 2 | Bicyclopyrone | 0.875 oz/A | 0.011 | PRE | 53 | 1.7 | 191 | 8.5 | 7 | 48 | 43 |
| 3 | Bicyclopyrone | 1.75 oz/A | 0.023 | PRE | 75 | 7 | 141 | 6.9 | 19 | 68 | 32 |
| 4 | Bicyclopyrone | 3.5 oz/A | 0.046 | PRE | 79 | 6.3 | 132 | 5.3 | 39 | 76 | 22 |
| 5 | Bicyclopyrone | 0.875 oz/A | 0.011 | 2-3 Lf | - | - | 229 | 7.3 | 37 | 49 | 36 |
| 6 | Bicyclopyrone | 1.75 oz/A | 0.023 | 2-3 Lf | - | - | 258 | 10.0 | 45 | 54 | 32 |
| 7 | Bicyclopyrone | 3.5 oz/A | 0.046 | 2-3 Lf | - | - | 244 | 7.3 | 56 | 73 | 25 |
| 8 | Tolpyralate | 0.5 oz/A | 0.013 | PRE | 69 | 0 | 242 | 8.0 | 6 | 61 | 39 |
| 9 | Tolpyralate | 1 oz/A | 0.026 | PRE | 79 | 28.5 | 121 | 6.3 | 67 | 76 | 31 |
| 10 | Tolpyralate | 2 oz/A | 0.052 | PRE | 71 | 25.1 | 101 | 6.0 | 64 | 70 | 30 |
| 11 | Tolpyralate | 0.5 oz/A | 0.013 | 2-3 Lf | - | - | 253 | 9.3 | 7 | 40 | 40 |
| 12 | Tolpyralate | 1 oz/A | 0.026 | 2-3 Lf | - | - | 300 | 7.3 | 36 | 64 | 18 |
| 13 | Tolpyralate | 2 oz/A | 0.052 | 2-3 Lf | - | - | 241 | 6.8 | 50 | 50 | 17 |
| 14 | Linuron | 1 lbs/A | 0.5 | PRE | 88 | 0 | 247 | 7.5 | 7 | 86 | 41 |
| 15 | Prometryn | 2 pt/A | 1.0 | PRE | 88 | 1.1 | 250 | 8.5 | 6 | 85 | 43 |
| 16 | Halosulfuron | 1 oz/A | 0.047 | PRE | 98 | 55.7 | 153 | 0.8 | 95 | 95 | 6 |
| 17 | Halosulfuron | 1 oz/A | 0.047 | CHEM1 | 65 | 3.6 | 219 | 7.0 | 22 | 53 | 39 |
| 18 | Halosulfuron | 1 oz/A | 0.047 | CHEM2 | - | - | 179 | 5.5 | 32 | 60 | 38 |
| 19 | Linuron | 1 lb/A | 0.5 | PRE | 93 | 2.6 | 239 | 7.0 | 20 | 91 | 42 |
| | EPTC | 3.5 pt/A | 3.1 | PRE | | | | | | | |
| 20 | EPTC | 3.5 pt/A | 3.1 | CHEM1 | 58 | 0 | 241 | 10.0 | 0 | 49 | 44 |
| 21 | EPTC | 5 pt/A | 3.1 | CHEM1 | 84 | 0.6 | 239 | 8.8 | 15 | 59 | 44 |
| 22 | EPTC | 3.5 pt/A | 4.4 | CHEM2 | - | - | 228 | 8.5 | 0 | 69 | 45 |
| 23 | EPTC | 5 pt/A | 4.4 | CHEM2 | - | - | 228 | 8.3 | 0 | 46 | 44 |
| | FPLSD (0.10) | | | | 21.7 | 42.1 | 79 | 2.6 | 37.9 | 21 | 8 |

**Table 7.** Carrot root yield, Pasco.

| | Treatment | Rate | | Timing | Carrot root harvest (15-Sept) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Clean Weight | Cull wt. | Grade | | | | Net root yield |
| | | | | | | | *<5/8" Diameter* | *5/8"-1 5/8" Dia.* | *> 1 5/8" Diam.* | *< 2" Length* | |
| | | *product* | *lb ai/A* | | ---------- *lb* ---------- | | | | | | *T/A* |
| 1 | Untreated | - - | - | - | 27.1 | 0.4 | 2.1 | 23.9 | 0.1 | 0.1 | 31.6 |
| 2 | Bicyclopyrone | 0.875 oz/A | 0.011 | PRE | 24.0 | 0.8 | 1.3 | 20.3 | 0.7 | 0.0 | 27.4 |
| 3 | Bicyclopyrone | 1.75 oz/A | 0.023 | PRE | 13.3 | 0.2 | 0.4 | 10.9 | 1.0 | 0.0 | 15.3 |
| 4 | Bicyclopyrone | 3.5 oz/A | 0.046 | PRE | 13.1 | 0.3 | 0.6 | 10.1 | 0.7 | 0.0 | 15.1 |
| 5 | Bicyclopyrone | 0.875 oz/A | 0.011 | 2-3 Lf | 20.7 | 0.2 | 2.1 | 18.1 | 0.1 | 0.0 | 24.3 |
| 6 | Bicyclopyrone | 1.75 oz/A | 0.023 | 2-3 Lf | 19.3 | 0.2 | 1.5 | 16.3 | 0.9 | 0.1 | 22.6 |
| 7 | Bicyclopyrone | 3.5 oz/A | 0.046 | 2-3 Lf | 14.7 | 0.3 | 0.4 | 13.1 | 0.6 | 0.0 | 17.0 |
| 8 | Tolpyralate | 0.5 oz/A | 0.013 | PRE | 21.4 | 0.6 | 1.2 | 18.9 | 0.4 | 0.0 | 24.5 |
| 9 | Tolpyralate | 1 oz/A | 0.026 | PRE | 19.1 | 0.4 | 0.4 | 13.0 | 5.2 | 0.0 | 22.2 |
| 10 | Tolpyralate | 2 oz/A | 0.052 | PRE | 15.5 | 0.6 | 0.3 | 9.1 | 5.1 | 0.0 | 17.6 |
| 11 | Tolpyralate | 0.5 oz/A | 0.013 | 2-3 Lf | 24.3 | 0.4 | 1.4 | 20.4 | 1.3 | 0.0 | 28.3 |
| 12 | Tolpyralate | 1 oz/A | 0.026 | 2-3 Lf | 11.8 | 0.3 | 0.1 | 8.8 | 1.8 | 0.0 | 13.5 |
| 13 | Tolpyralate | 2 oz/A | 0.052 | 2-3 Lf | 3.9 | 0.0 | 0.1 | 3.0 | 0.1 | 0.1 | 4.5 |
| 14 | Linuron | 1 lbs/A | 0.5 | PRE | 23.4 | 0.3 | 3.4 | 19.3 | 0.1 | 0.1 | 27.4 |
| 15 | Prometryn | 2 pt/A | 1.0 | PRE | 25.9 | 0.3 | 2.2 | 22.1 | 0.4 | 0.1 | 30.4 |
| 16 | Halosulfuron | 1 oz/A | 0.047 | PRE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 17 | Halosulfuron | 1 oz/A | 0.047 | CHEM1 | 23.2 | 0.8 | 2.1 | 19.4 | 0.2 | 0.0 | 26.1 |
| 18 | Halosulfuron | 1 oz/A | 0.047 | CHEM2 | 20.2 | 0.4 | 1.9 | 16.5 | 0.8 | 0.1 | 23.3 |
| 19 | Linuron | 1 lb/A | 0.5 | PRE | 23.7 | 0.3 | 2.5 | 20.3 | 0.2 | 0.1 | 27.6 |
| | EPTC | 3.5 pt/A | 3.1 | PRE | | | | | | | |
| 20 | EPTC | 3.5 pt/A | 3.1 | CHEM1 | 23.4 | 0.5 | 2.4 | 20.2 | 0.1 | 0.0 | 27.2 |
| 21 | EPTC | 5 pt/A | 3.1 | CHEM1 | 27.1 | 0.2 | 3.5 | 23.1 | 0.0 | 0.1 | 31.8 |
| 22 | EPTC | 3.5 pt/A | 4.4 | CHEM2 | 25.2 | 0.4 | 3.2 | 21.2 | 0.0 | 0.1 | 29.3 |
| 23 | EPTC | 5 pt/A | 4.4 | CHEM2 | 27.2 | 0.3 | 1.7 | 24.8 | 0.0 | 0.0 | 31.9 |
| | FPLSD (0.10) | | | | 6.2 | ns | 1.6 | 5.7 | 2.4 | ns | 7.4 |