# COMPARISON OF POTENTIAL RETURNS FROM GRAPES, BLUEBERRIES, AND STRAWBERRIES FOR NORTH-CENTRAL FLORIDA ${ }^{1}$ 

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Abstract. Blueberries, strawberries, and muscadine grapes are commercially grown in North-central Florida. Although these fruits and berries are primarily marketed through pick-your own operations, the potential for fresh market sales exists. For the individual considering investment into the production and marketing of any fruit, the logical selection is the cultivar that yields the higher grower return, ceteris paribus. Determination of the investment's financial feasibility requires the enumeration of anticipated capital and operating requirements and a projection of revenue. In this paper, a comparison of potential grower returns is presented utilizing estimated breakeven costs and returns applicable to the production and marketing of Florida grapes, blueberries, and strawberries.

Strawberries, blueberries, and grapes are popular fruit crops among home gardeners and commercial fruit growers in North-central Florida. These fruits are popular with home gardeners because the consumptive requirements of a family can be grown on a small plot of land and these fruits are relatively easy to grow. Commercial farmers find that blueberries, strawberries, or grapes fit in well with a mixed farming operation or as a one-crop enterprise.

Currently about 325 acres of muscadine grapes, 400 acres of rabbiteye blueberries, and 60 acres of strawberries are being produced in North-central Florida (2). Acreage is also being prepared for additional commercial plantings of these fruits. The commercial production has been primarily for pick-your-own and roadside market sales, although the potential for developing or expanding fresh market sales has aroused interest in cost and return information.

A positive return on capital outlay to commercial fresh market operations can be anticipated when recommended production and marketing practices are followed. Potential fruit growers in North-central Florida can use the information in this report as a guide in evaluating the break-even market price necessary to cover the anticipated operating expenses and capital outlays for producing and marketing quality blueberries, grapes, and strawberries.

## Budgets

The costs of operation presented in the following budgets reflect the equipment, labor, and activities needed for 20 acres of commercial production. Such tracts of blueberries and grapes have been established in North-central Florida. Although a 20 -acre tract of strawberries is not common for North-central Florida, such strawberry operations are found in South-central Florida. This is not to imply that 20 acres of production is needed for a commercial fresh market operation, but merely provides a common

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Table 3. Estimated variable costs per acre for a 20-acre strawberry farm in North-central Florida, 1980.

| Item | Cost/Acre |
| :---: | :---: |
| Pre-Harvest |  |
| Remove plastic from previous crop |  |
| 8 hours labor at $\$ 3.50$ per hour | \$ 28.00 |
| Disk, twice, 1.5 hours each |  |
| Tractor, driver, \& disk at $\$ 6.59$ per hour | 19.77 |
| Plant cover crop, once, .5 hour at $\$ 6.59$ per hour |  |
| Rotovate cover crop, 4 times, 1.5 hours each |  |
| Tractor, driver \& rotovator at $\$ 7.07$ per hour | 42.54 |
| Lay off rows, once, 1.0 hour |  |
| Tractor and driver at \$5.71 per hour | 5.71 |
| Fertilize, once 1.0 hour |  |
| Tractor, spreader and driver at $\$ 6.23$ per hour |  |
| Fertilizer, 1.5 ton at $\$ 100$ per ton |  |
| Dolomite, 1 ton every 3 years at $\$ 24$ per ton | 164.23 |
| Fumigate, once, 4.0 hours |  |
| Tractor, fumigator, and driver at $\$ 7.09$ per hour |  |
| Additional labor at $\$ 3.50$ per hour |  |
| Fumigant, 195 pounds at \$1.00 per pound |  |
| Plastic, $11000^{\prime}$ x $44^{\prime \prime}$ at $\$ 19$ per 1000 feet | 426.36 |
| Set Plants |  |
| 40 hours labor at $\$ 3.50$ per hour |  |
| 23,000 plants at $\$ 36$ per 1000 | 968.00 |
| Cultivate, 3 times, 1.0 hour each |  |
| Tractor, cultivator, and driver at $\$ 5.89$ per hour | 17.67 |
| Spray, 36 times, 5 hour each |  |
| Tractor, driver, and sprayer at $\$ 6.23$ per hour |  |
| Captan, Benlate, Dibron, Plictran and Phosdrin |  |
| as recommended | 867.54 |
| Irrigation Electricity | 50.00 |
| Interest on Pre-harvest Activities |  |
| Total Pre-Harvest Cash Costs/Acre | \$2,852.60 |
| Harvest and Marketing | Cost/Flat |
| Picking labor | \$ 1.10 |
| Labor benefits | . 14 |
| Containers | . 60 |
| Packing shed labor | . 10 |
| Labor bonus | . 10 |
| Supervision | . 10 |
| Transport | . 05 |
| Market preparation (including marketing and advertising) | . 50 |
| Total Harvest and Marketing Costs/Flat | \$ 2.69 |

will forego a self-sustaining income stream for the first few years. Strawberries, on the other hand, are considered an annual and generate an economic return the same season the plants are set.

The economic analysis further assumes proper production management practices, such as confirming compatibility of choice of fruit with soil type and drainage, proper variety selection, and suitability and adaptability to prevalent environmental characteristics, are evaluated prior to setting plants.

## Strawberries

The estimated investment costs in equipment anticipated for preparing the plant bed and producing 20 acres of strawberries (4) in North-central Florida are presented in Table 1. The costs reflect capital expenditures in equipment of $\$ 74,800$ and annual depreciation of $\$ 7,701$. The land was assumed to have an acquisition cost of $\$ 2,000$ per acre for a total land and equipment investment of $\$ 114,800$.

The estimated annual fixed costs of $\$ 1,161$ per acre for the aforementioned equipment and land are presented in Table 2. The estimated variable costs of producing and

Table 4. Estimated investment and depreciation costs for a 20 -acre blueberry farm in North-central Florida, 1980.

| Item | Cost | Years Life | Annual Depreciation ${ }^{2}$ |
| :---: | :---: | :---: | :---: |
| Equipment |  |  |  |
| 40 HP Tractor with Loader | \$ 14,500 | 7 | \$1,865 |
| Fertilizer Spreader | 700 | 8 | 79 |
| Rotary Mower | 1,300 | 10 | 117 |
| Sprayer | 2,000 | 5 | 360 |
| $10^{\circ}$ Disk Harrow | 2,000 | 8 | 225 |
| Moldboard Plow | 2,000 | 10 | 180 |
| 2 -Ton Truck | 12,000 | 7 | 1,543 |
| Irrigation Welly | 16,500 | 12 | 1,238 |
| Irrigation Systemx | 20,400 | 10 | 1,836 |
| Portable Packing Shed | 1,000 | 10 | 90 |
| Total Equipment | \$72,400 |  | \$7,533 |
| $\underline{\text { Land }}$ |  |  |  |
| 20 acres @ \$2,000/acre | \$ 40,000 |  | NonDepreciable |
| Total Land and Equipment | \$112,400. |  | \$7,533 |
| Blueberry Plantsw |  |  |  |
| 500 Plants/acre @ \$3.00 each | \$ 30,000 | 20 | \$1,500 |
| Total Land, Equipment \& Plants | \$142,400 |  | \$9,033 |

${ }^{2}($ Cost minus $10 \%) \div$ Years Life.
yIncludes Well Drilling and Casing ( $6^{\prime \prime}$ x 300'), Power Unit (64 Continuous Brake HP) Turbine ( 600 GPM), and Set.
xIncludes Pipe, Sprinkler Heads and Tubing, and Installation © \$1020/acre.
w450 Plants/acre plus $10 \%$ Replacement; Straight Line Depreciation, no salvage.
harvesting strawberries are itemized by activity in Table 3. The variable production costs of $\$ 2,853$ are cited on a cost per acre basis whereas the harvesting and marketing costs are stated on a cost per flat of $\$ 2.69$.

Table 5. Estimated total and per acre fixed costs for land and equipment for a 20 -acre blueberry farm in North-central Florida, 1980.

| Item | Cost |
| :---: | :---: |
| Machinery Fixed Costs |  |
| Depreciationz | \$7,533 |
| Interesty | 6,864 |
| Repairsx | 2,059 |
| Taxesw | 1,030 |
| Insurancev | 343 |
| Truck Tag and Insurance | 1,000 |
| Total Machinery Fixed Costs | $\overline{\$ 18,829}$ |
| Land Fixed Costs |  |
| Interestu | \$ 3,400 |
| Taxest | + 480 |
| Total Land Fixed Costs | \$ 3,880 |
| Plant Fixed Costs |  |
| Depreciationz | \$ 1,500 |
| Insurance and Taxess | 1,000 |
| Total Plant Fixed Costs | \$ 2,500 |
| Total Fixed Costs | \$25,209 |
| Fixed Costs per Acre | \$ 1,260 |

${ }^{2}$ From Table 4.
$\mathrm{y} 10.0 \%$ of Average Investment; Average Investment $=\$ 68,634$.
$\times 3.0 \%$ of Average Investment.
w $1.5 \%$ of Average Investment.
$\mathrm{v} 0.5 \%$ of Average Investment.
u8.5\% of Land Investment.
t $\$ 24$ per Acre.
s $\$ 50$ per Acre.

Table 6. Estimated variable costs per acre for a 20-acre blueberry farm in North-central Florida, 1980.

| Item | Cost/Acre |
| :---: | :---: |
| Establishment |  |
| Plow land, once 0.5 hour |  |
| Tractor, plow, and driver at $\$ 6.63$ per hour | \$ 3.32 |
| Disk harrow, twice, 0.3 hour each |  |
| Tractor, disk, and driver at $\$ 6.59$ per hour | 3.96 |
| Lay off rows, once, 0.5 hour |  |
| Tractor and driver at $\$ 5.71$ per hour | 2.86 |
| Open furrows, twice. 0.4 hour each |  |
| Tractor and driver at $\$ 5.17$ per hour | 4.57 |
| Apply peat moss, once, 2.0 hours |  |
| Tractor, trailer, and driver at \$5.80 per hour | 11.60 |
| Fertilize, once, 1.0 hour |  |
| Tractor, spreader, and driver at $\$ 6.23$ per hour |  |
| Fertilizer, 0.2 tons at $\$ 100$ per ton | 26.23 |
| Set blueberry plants, 5.0 hours |  |
| Tractor, trailer, and driver at $\$ 5.80$ per hour | 29.00 |
| Mulch beds, 5.0 hours |  |
| Tractor, trailer, and driver at $\$ 5.80$ per hour | 29.00 |
| Irrigation electricity | 24.00 |
| Total Establishment Variable Costs | \$134.54 |
| Annual Development (or Pre-Harvest) Costs |  |
| Fertilize, once, 1.0 hour |  |
| Tractor, spreader, and driver at $\$ 6.23$ per hour |  |
| Fertilizer, 0.3 tons at $\$ 100$ per ton | \$ 36.23 |
| Spray, 10 times, 0.5 hour each |  |
| Tractor, sprayer, and driver at \$6.23 per hour |  |
| Difolatan, Roundup, Paraquat, Insecticide, \& Fungicide |  |
| Mowing, 10 times, 0.4 hour each |  |
| Tractor, mower, and driver at $\$ 7.64$ per hour | 30.56 |
| Pruning and hoeing, 20 hours |  |
| Labor at \$3.50 per hour | 70.00 |
| Irrigation Electricity | 36.00 |
| Interest on establishment and pre-harvest costs ( $\$ 409.89+\$ 134.53$ ) at $13 \%$ for 9 months | Interest on establishment and pre-harvest costs |
| Total Development and Pre-Harvest Cash Costs | \$462.97 |

Harvesting and Marketing Cost/Flat

| Picking labor | $\$$ | 1.80 |
| :--- | ---: | ---: |
| Labor benefits |  | .14 |
| Containers | .60 |  |
| Market preparation (including marketing and advertising) | .76 |  |
| Transport | .05 |  |
| Supervision |  | .10 |
| Total Harvesting and Marketing Cost/Flat (12 Pints) | $\$$ | $\mathbf{3 . 4 5}$ |

## Blueberries

The estimated investment and depreciation costs for 20 acres of blueberries in North-central Florida (5) are presented in Table 4. Total investment in equipment amounts to $\$ 72,400$. Since blueberries have an estimated 20 -year life, the cost of the plants is considered an investment and is depreciable. The total investment in land, equipment, and plants is $\$ 142,400$ for 20 acres of production. The annual depreciation is $\$ 9,033$ on equipment and plants.

Table 5 summarizes the estimated fixed costs per acre of $\$ 1,260$ for land and equipment for blueberry production. The estimated variable costs per acre (Table 6) are twofold: variable establishment costs of $\$ 134.54$ per acre and variable development or pre-harvest costs of $\$ 462.97$ per acre. The harvest and marketing costs of $\$ 3.45$ (Table 6) are itemized on a cost per flat basis, where a flat is a 12 pint module.

Table 7. Estimated investment and depreciation costs for a 20-acre Muscadine grape vineyard in North-central Florida, 1980.

| Item | Cost | Years Life | Annual Depreciation |
| :---: | :---: | :---: | :---: |
| Equipment |  |  |  |
| 40 HP Tractor with Loader | \$ 14,500 | 7 | \$1,865 |
| Fertilizer Spreader | 700 | 8 | 79 |
| Rotary Mower | 1,300 | 10 | 117 |
| Sprayer | 2,000 | 5 | 360 |
| $10^{\prime}$ Disk Harrow | 2,000 | 8 | 225 |
| Moldboard Plow | 2,000 | 10 | 180 |
| 2-Ton Truck | 12,000 | 7 | 1,543 |
| Irrigation Welly | 16,500 | 12 | 1,238 |
| Irrigation System (Drip) ${ }^{\text {x }}$ | 20,400 | 10 | 1,836 |
| Portable Packing Shed | 1,000 | 10 | 90 |
| Posts and Trellis Wire | 625 | 10 | 57 |
| Total Equipment | \$73,025 |  | \$7,590 |
| Land |  |  |  |
| 20 acres@ \$2,000/acre | \$ 40,000 |  | Non-Depreciable |
| Total Land and Equipment | \$113,025 |  | \$7,590 |
| Muscadine Grape Plantsw |  |  |  |
| 200 Plants/acre @ $\$ 1.50$ each | \$ 6,000 | 20 | \$ 300 |
| Total Land, Equipment \& Plants | \$119,025 |  | \$7,890 |

${ }^{2}($ Cost minus $10 \%) \div$ Years Life.
yIncludes Well Drilling and Casing ( $6^{\prime \prime} \times 300^{\prime}$ ), Power Unit ( 65 Continuous Brake HP), Turbine ( 600 GPM), and Set.
xIncludes Pipe, Sprinkler Heads and Tubing, and Installation @ $\$ 1020 / \mathrm{acre}$.
${ }^{w} 180$ Plants/acre plus $10 \%$ Replacement; Straight Line Depreciation, no salvage.

Table 8. Estimated total and per acre fixed fot land and equipment for a 20 -acre Muscadine grape vineyard in North-central Florida, 1980.

| Item | Cost |
| :---: | :---: |
| Machinery Fixed Costs |  |
| Depreciationz | \$7,590 |
| Interesty | 6,923 |
| Repairsx | 2,077 |
| Taxesw | 1,039 |
| Insurancer | 346 |
| Truck Tag and Insurance | 1,000 |
| Total Machinery Fixed Costs | \$18,975 |
| Land Fixed Costs |  |
| Interestu | \$ 3,400 |
| Taxest | 480 |
| Total Land Fixed Costs | \$ 3,880 |
| $\underline{\text { Plants Fixed Costs }}$ |  |
| Depreciationz | \$ 300 |
| Insurance and Taxess | 800 |
| Total Plant Fixed Costs | \$1,100 |
| Total Fixed Costs | \$23,955 |
| Fixed Costs Per Acre | \$ 1,198 |

## zFrom Table 7.

$y 10.0 \%$ of Average Investment; Average Investment $=\$ 169,230$.
$\times 3.0 \%$ of Average Investment.
w $1.5 \%$ of Average Investment.
v0.5\% of Average Investment.
u8.5\% of Land Investment.
t $\$ 24$ per Acre.
s $\$ 40$ per Acre.

## Grapes

The estimated $\$ 119,025$ total investment (Table 7) includes the equipment for land preparation and production of grapes, the land, and the grape vines for 20 acres of muscadine grapes in North-central Florida (3). Associated with this investment is an annual depreciation cost of $\$ 4,890$.

The estimated fixed costs per acre (Table 8) amount to $\$ 1,198$, including costs attributed to land, equipment, and the grapevines. As with the blueberries, the estimated variable costs per acre for grape production are two-fold: variable establishment costs of $\$ 315.15$ per acre and variable development and pre-harvest costs of $\$ 343.10$ per acre, as shown in Table 9 . The variable harvesting and marketing costs are estimated to be $\$ 3.05$ per flat (Table 9 ), where a flat is composed of 12 pints.

Table 9. Estimated variable costs per acre for a 20 -acre Muscadine grape vineyard in North-central Florida, 1980.

| Item | Cost/Acre |
| :---: | :---: |
| Establishment |  |
| Plow land, once, 0.5 hour |  |
| Tractor, plow, \& driver at \$6.63 per hour \$3.32 |  |
| Apply lime, once, 1.0 hour |  |
|  |  |
| Lime, 2 tons at $\$ 18.00$ per ton | 42.32 |
| Disk harrow, twice, 0.3 hour each |  |
| Tractor, disk, and driver at \$6.59 per hour 3.96 |  |
| Lay off rows, once, 0.5 hourTractor and driver at $\$ 5.71$ per hour 2.8 |  |
|  |  |
| Open furrows, twice, 0.4 hour each |  |
| Open furrows, twice, 0.4 hour each ${ }_{\text {Tractor and driver at } \$ 5.71 \text { per hour }}$ |  |
| Set grape vines, 3.0 hours ${ }^{\text {Tractor, trailer, and driver at } \$ 5.80 \text { per hour } 17.40}$ |  |
|  |  |
| Fertilize, once, 1.0 hour |  |
| Tractor, spreader, and driver at $\$ 6.23$ per hour Fertilizer, $11 / 4$ tons at $\$ 100$ per ton | 131.23 |
| Spray, 5 times, 0.5 hour each |  |
|  |  |
| Herbicide, Insecticide, and Fungicide as recommended | 85.58 |
| Irrigation Electricity | 24.00 |
| Total Establishment Variable Costs | \$315.15 |
| Annual Development and Pre-Harvest Costs |  |
|  |  |
| Tractor, spreader, and driver at $\$ 6.23$ per hour Fertilizer, 5 tons at $\$ 100$ per ton | \$ 56.23 |
| Apply lime, once, 1.0 hour |  |
| Tractor, spreader, and driver at $\$ 6.23$ per hour Lime, 0.33 ton at $\$ 18.00$ per ton | 12.23 |
| Spray, 5 times, 0.5 hour each |  |
| Tractor, sprayer, and driver at $\$ 6.23$ per hour |  |
| Herbicide, Fungicide, and Insecticide as recommended 85 |  |
|  |  |
| Pruning and hoeing, 20 hours |  |
| Labor at $\$ 3.50$ per hour | 70.00 |
| Irrigation Electricity |  |
| $(\$ 290.60+\$ 315.15)$ at $13 \%$ for 8 months | 52.50 |
| Total Development and Pre-Harvest Cash Cost | \$343.10 |
| Harvesting and Marketing | Cost/Flat |
| Picking labor | \$ 1.44 |
| Labor benefits | . 14 |
| Containers | . 60 |
| Market preparation (including marketing and advertising) | . 72 |
| Transport | . 10 |
| Total Harvesting and Marketing Costs/Flat (12 Pints) | \$ 3.05 |

## Break-Even Markeł Prices

The market prices necessary to cover the fixed and variable costs of producing strawberries, blueberries, and grapes in North-central Florida are shown in Tables 10, 11, and 12, respectively. The market prices are presented for each of three yield levels (low, good, and high) considered appropriate for each fruit. These break-even prices are for the commercial grower marketing his produce through fresh market sales. If the grower is marketing his produce through pick-your-own sales and/or roadside markets, the harvesting and marketing costs per flat would be lower, thereby indicating a lower break-even price. The 1980 average market value for 12 pints (a flat) of strawberries, blueberries, and grapes is annotated with the grower return that can be anticipated.

## Summary

Enterprise budgets and break-even analyses, such as presented in this paper, are aids in making managerial de-
Table 10. Market prices necessary to cover production costs and fixed costs for a 20 -acre strawberry farm in North-central Florida, 1980.

| Yield level | Pre-harvest <br> costs | Pre-harvest, <br>  <br> costs | marketing <br> costs | Pre-harvest, <br> harvest, <br> marketing <br> $\&$ fixed <br> costs |
| :--- | :---: | :---: | :---: | :---: | :---: |
| costs |  |  |  |  |

Table 11. Market prices necessary to cover production and fixed costs for a 20 -acre blueberry farm in North-central Florida, 1980.

| Yield level | Pre-harvest costs | Harvest \& marketing costs | Pre-harvest, harvest \& marketing costs | Fixed costs | Pre-harvest harvest, marketing \& fixed costs |
| :---: | :---: | :---: | :---: | :---: | :---: |
| flats/acre. |  |  | \$/flat |  |  |
| Low (250) | \$1.86 | \$3.45 | \$5.31 | \$5.04 | \$10.35 |
| Good (750) | . 62 | 3.45 | 4.07 | 1.68 | 5.75 |
| High (1250) | . 37 | 3.45 | 3.82 | 1.01 | 4.83 |
| 1980 Average market value per 12 pints $\begin{gathered}\text { (fresh market) } \ldots \ldots \ldots . \$ 8.75 \\ \text { (pick-your-own) } \ldots \ldots \ldots . \$ 7.15\end{gathered}$ |  |  |  |  |  |

Table 12. Market prices necessary to cover production costs and fixed costs for a 20 -acre Muscadine grape vineyard in North-central Florida, 1980.

| Yield level | $\begin{aligned} & \text { Pre-harvest } \\ & \text { costs } \end{aligned}$ | Harvest \& Marketing costs | Pre-harvest, harvest \& marketing costs | Fixed costs | Pre-harvest harvest, marketing \& fixed costs |
| :---: | :---: | :---: | :---: | :---: | :---: |
| . flats/acre. |  |  | \$/flat |  |  |
| Low (150) | \$2.29 | \$3.05 | \$5.34 | \$7.99 | \$13.33 |
| Good (450) | .77 | 3.05 | 3.82 | 2.67 | 5.49 |
| High (750) | .46 | 3.05 | 3.51 | 1.60 | 5.11 |

1980 Average market value per 12 pints (pick-your-own) ...... $\$ 6.30$
cisions. The presented material is best used as a guide for evaluating the anticipated economic returns from producing either strawberries, blueberries, or grapes in North-central Florida. Although profits can be realized by following recommended production practices, sound management dictates careful economic planning and marketing by the efficient fruit grower.

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## GLYPHOSATE RESIDUES ON AVOCADO ${ }^{1}$

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Abstract. Glyphosate [ N -(Phosphonomethyl) glycine] was used for weed control in avocado (varieties "Meya" and "Lula"), and samples were taken at maturity. Whole fruit was analysed for glyphosate and the metabolite aminomethylphosphonic acid using flame photometric gas chromatography. The maximum residue found was 0.08 ppm .

The herbicide glyphosate has been shown to give excellent weed controls. The purpose of this research was to supply residue data in support of a registration for use on avocado.

## Materials and Methods

Glyphosate ( $41 \%$ isopropylamine salt) was used for weed control in avocado (varieties "Meya" and "Lula"). Two different rates were used, the recommended rate (X) of 4 lb ai/acre and a higher rate (2X) of 8 lb ai/acre. Each plot consisted of 4 trees per row in 4 rows spread 30 feet apart. The spray was boom directed in a 6 feet wide strip on each side of a row of trees. Weed control applications were made three times, the first interval being 13 weeks and the second 11 weeks. Avocado samples were taken at maturity, 1 and 14 days following the final treatment. The fruit was hand picked and frozen whole prior to analysis for glyphosate and the metabolite aminomethylphosphonic acid.

For residue analysis, the fruit was partially thawed and cut open to remove the pit and chopped in a Hobart food chopper. A representative 25 g sample was blended with

[^0]Proc. Fla. State Hort. Soc. 93: 1980.

50 ml deionized distilled water and 25 ml chloroform in a Polytron ${ }^{\mathrm{R}}$ (Brinkmann Instruments) ultra-sonic homogenizer and centrifuged to separate the two layers. The aqueous layer was decanted and the process was repeated. The aqueous layers were pooled, diluted to 1000 ml and passed through a Diamond Shamrock A-101D anion exchange resin ( 25 ml resin on a $2.2 \times 30 \mathrm{~cm}$ column prewashed with 100 ml IM ammonium bicarbonate solution and then with three 100 ml rinses of deionized water) at the rate of ca 800 ml per hour followed with three 100 ml portions of deionized water. All of the preceding volumes were discarded. The parent herbicide and the metabolite were eluted from the column with 100 ml 0.5 M ammonium bicarbonate solution. The eluate was evaporated to dryness using a flash evaporator at $50^{\circ} \mathrm{C}$. Evaporation was done twice, each time the flask was rinsed with 50 ml deionized water. The final residue was dissolved in 5 ml deionized water and transferred to a Bio-Rad cation exchange resin AG 50W-X8 column ( $1.0 \times 20 \mathrm{~cm}$ filled with resin to 14.5 cm , prewashed with 75 ml deionized water) and eluted with water. The fractions to be collected were determined by using ${ }^{14} \mathrm{C}$-labeled gly-


Fig. 1. Chromatogram of glyphosate standard.


[^0]:    1Florida Agricultural Experiment Station Journal Series No. 2829.

