

Worksheet: Potassium Citrate Foliar Study

Overview

This study investigates the molar and practical mixing relationships between **Potassium Bicarbonate (KHCO_3)** and **Citric Acid ($\text{C}_6\text{H}_8\text{O}_7$)**, analyzing reaction balance, pH behavior, electrical conductivity (EC), and practical applicability for agricultural and industrial uses. Two batch scales are analyzed: **1-gallon lab-scale** and **16-gallon field-scale**.

Key Chemistry & Constants

Compound	Molar Mass (g/mol)	Grams per 1 Gallon	Moles per 1 Gallon	Grams per 16 Gallons	Moles per 16 Gallons
Citric Acid	192.124	8.5 g	0.044 mol	136 g	0.708 mol
Potassium Bicarbonate	100.115	Variable (see table)	Ratio $\times$ 0.044 mol	Variable	Ratio $\times$ 0.708 mol

Balanced Molar Equation occurs at **3:1 ratio** (KHCO_3 :Citric Acid), producing water, potassium citrate, and CO_2 (fizzing observed).

Key Values:

Citric Acid: $136 \text{ g} \div 16 = \mathbf{8.5 \text{ g per gallon}}$

Citric Acid Moles: $8.5 \text{ g} \div 192.124 \text{ g/mol} \approx \mathbf{0.044 \text{ mol}}$

KHCO_3 mass is scaled per gallon based on molar ratios to this fixed 0.044 mol of citric acid

Fixed Parameters:

Citric Acid per gallon: 8.5 g (0.044 mol)

Citric Acid per 16 gallons: 136 g (0.708 mol)

Mixing Procedure Guidelines

1-Gallon Laboratory Protocol

1. Measure **8.5 g citric acid** and dissolve in **1 gallon** clean water.
2. Add KHCO_3 per the test ratio from the table.
3. Stir until dissolved.
4. Record **pH**, **EC**, **PPM**, and **visual reactions**.

1-Gallon Reaction Table

Test #	KHCO_3 Ratio	KHCO_3 (mol)	KHCO_3 (g)	Citric Acid (g)	Notes
0	0:1	0.000	0.00	8.5	Ultra Acidic
1	0.25:1	0.011	1.10	8.5	Ultra Acidic
2	0.5:1	0.022	2.21	8.5	Extremely Acidic
3	0.75:1	0.033	3.31	8.5	Extremely Acidic
4	1:1	0.044	4.41	8.5	Strongly Acidic
5	1.5:1	0.066	6.62	8.5	Strongly Acidic
6	2:1	0.088	8.82	8.5	Moderately Acidic
7	2.5:1	0.110	11.03	8.5	Balanced Molar Equation
8	3:1	0.132	13.23	8.5	Moderately Acidic
9	3.5:1	0.154	15.44	8.5	Slightly Acidic
10	4:1	0.176	17.64	8.5	Slightly Acidic
11	5:1	0.220	22.05	8.5	Slightly Acidic
12	6:1	0.264	26.46	8.5	Neutral
13	7:1	0.308	30.88	8.5	Slightly Alkaline
14	1:0	0.044	4.41	0.0	Ultra Acidic

16-Gallon Field Protocol (Standard Tote)

1. Fill a 16-gallon tote with 15 gallons of water.
2. In 0.5 gallon: dissolve **136 g citric acid** (fixed).
3. In another 0.5 gallon: dissolve KHCO_3 per test ratio.
4. Add both to tote. Mix thoroughly.
5. Use immediately. Optional: record **pH, EC, PPM**.

*(Other Gallon Size Adjust Mixture Accordingly)

16-Gallon Field Mixing Table

Test #	KHCO_3 Ratio	KHCO_3 (mol)	KHCO_3 (g)	Citric Acid (g)	Notes
0	0:1	0.000	0.00	136	Ultra Acidic
1	0.25:1	0.177	17.74	136	Ultra Acidic
2	0.5:1	0.354	35.48	136	Extremely Acidic
3	0.75:1	0.531	53.22	136	Extremely Acidic
4	1:1	0.708	70.97	136	Strongly Acidic
5	1.5:1	1.062	106.46	136	Strongly Acidic
6	2:1	1.416	141.95	136	Moderately Acidic
7	2.5:1	1.770	177.43	136	Balanced Molar Equation
8	3:1	2.124	212.92	136	Moderately Acidic
9	3.5:1	2.478	248.41	136	Slightly Acidic
10	4:1	2.832	283.90	136	Slightly Acidic
11	5:1	3.540	354.87	136	Slightly Acidic
12	6:1	4.248	425.84	136	Neutral
13	7:1	4.956	496.81	136	Slightly Alkaline
14	1:0	0.708	70.97	0.0	Ultra Acidic

Analytical Recording Table (For Each Test)

Test #	KHCO ₃ : CA Ratio	pH	EC (mS/cm)	PPM (mg/L)	Notes
0	0:1				
1	0.25:1				
2	0.5:1				
3	0.75:1				
4	1:1				
5	1.5:1				
6	2:1				
7	2.5:1				
8	3:1				
9	3.5:1				
10	4:1				
11	5:1				
12	6:1				
13	7:1				
14	1:0				

Researcher Questionnaire

General Information

Date of Test: _____

Tested by: _____

Lab/Facility: _____

Water Source: ☐ Distilled ☐ RO ☐ Tap ☐ Other: _____

Starting EC: _____ Starting pH: _____

Instrumentation & Calibration

Measurement Instrument Used Brand / Model Last Calibration Method

pH Meter

EC Meter

PPM Meter

Scale

Observational Checklist

Fizzing/Gas Release: ☐ Yes ☐ No

-
-
-
-

Describe intensity/duration:

Color Change Observed: ☐ Yes ☐ No

Describe:

Precipitation/Cloudiness: ☐ Yes ☐ No

Solution Temp: _____ °C / °F

Temperature Controlled? ☐ Yes ☐ No

Summary Section

Most stable/ideal ratio (by pH or behavior):

General behavior comments:

Scalability/Field Suitability:

Recommended Use Applications:
