







Fertilizer Compatibility

Joceline Alfaro

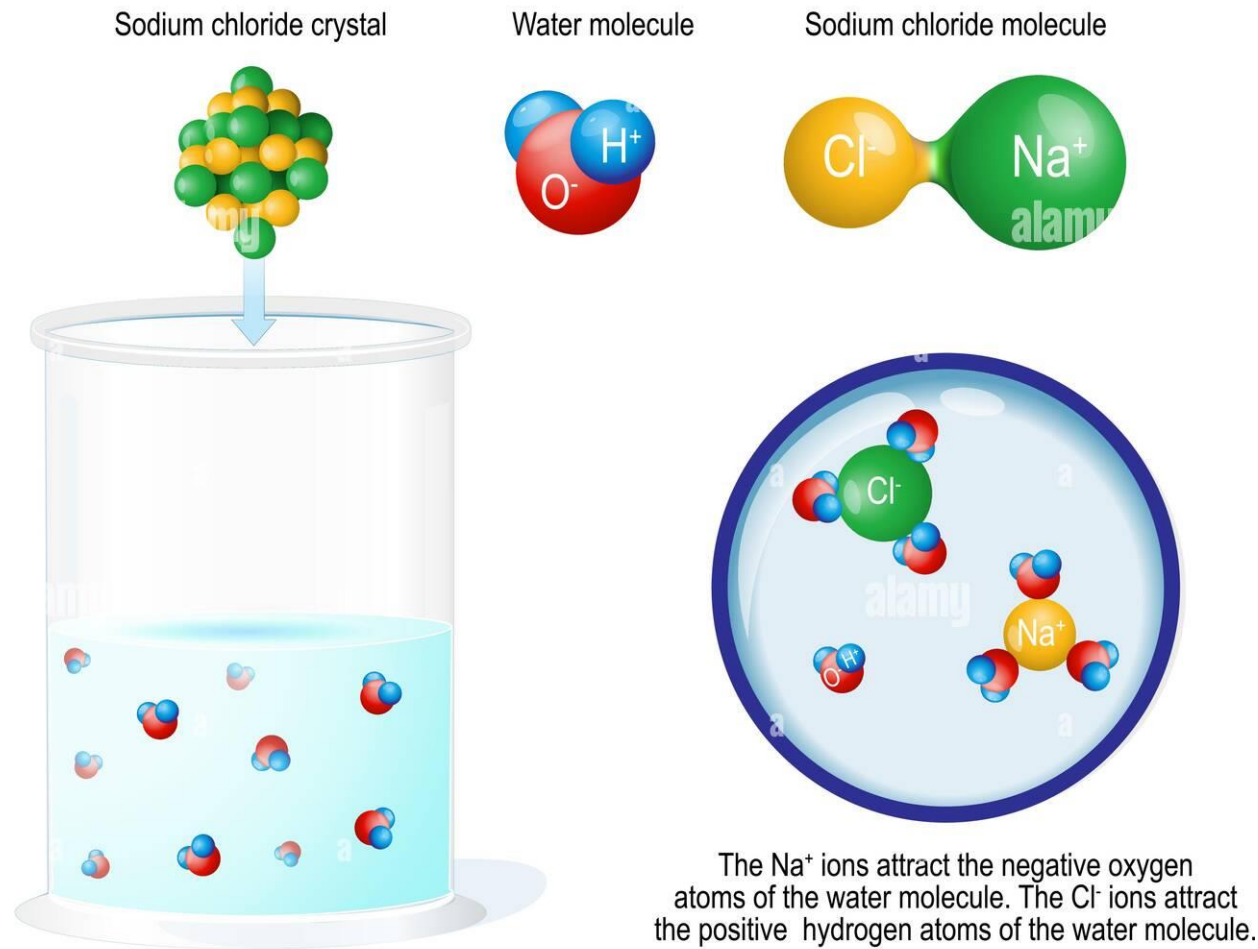
ADVANCED AGRONOMY
BOOTCAMP

Presentation Topics

-  Micronutrient Compatibility
-  NPK Compatibility
-  New Product/Nutrio/Humic Compatibility
-  Jar Testing



How does sodium chloride (NaCl) dissolve in water?



alamy

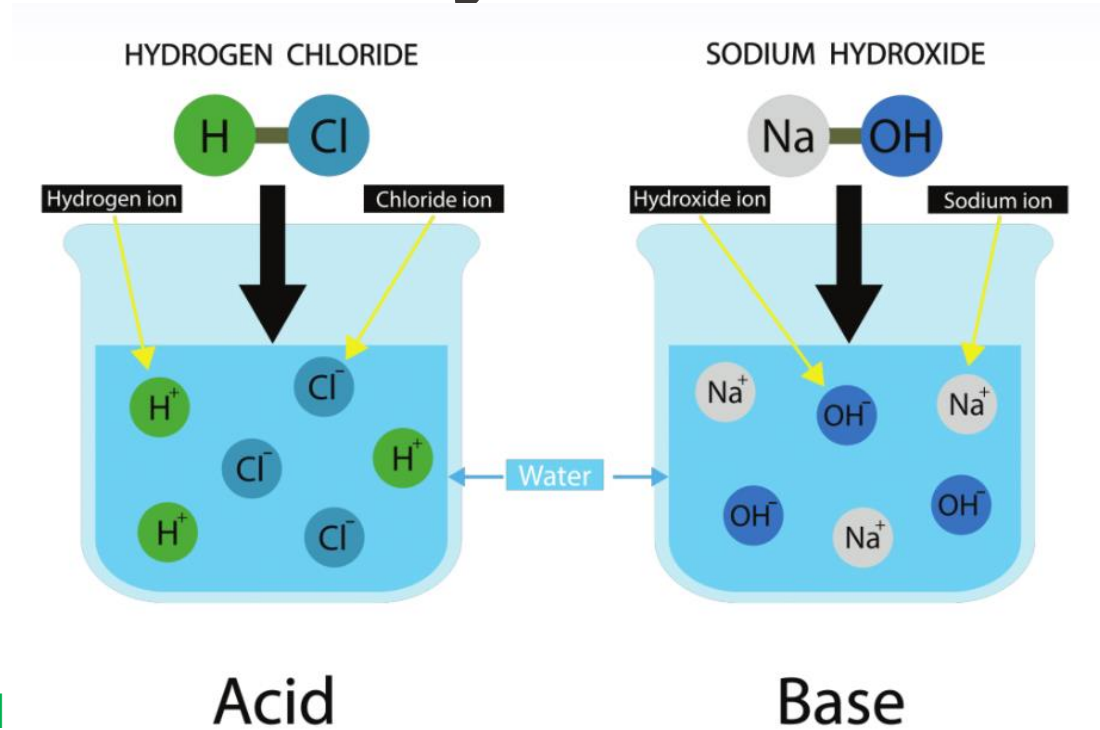
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www.alamy.com



Acidity vs Alkalinity

Acidity

- High concentration of hydrogen ions (H^+)
- Hydrogen donors are called acids:
 - H_3PO_4
 - HNO_3
 - H_2SO_4



Alkalinity

- High concentration of hydroxide ions (OH^-)
- Hydroxide donors are called bases:
 - KOH
 - NH_4OH
 - $NaOH$

Micronutrient Compatibility

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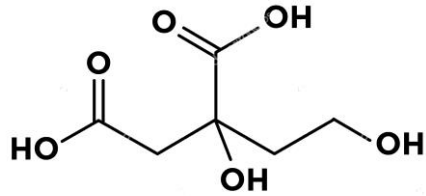


Complexed Micros

- Metal cation paired with a non-metal anion to increase solubility, concentration, and availability
- Anion can be: Citric Acid, Lignosulfonate, Amino Acids, Nitrate, Gluconic Acid, ???
- Soluble in pH >4



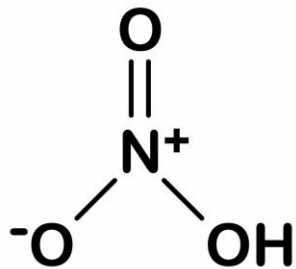
CITRIC ACID $C_6H_8O_7$



depositphotos

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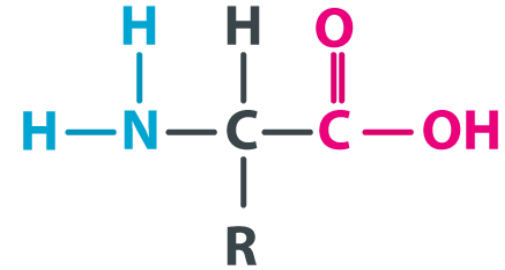


NITRIC ACID

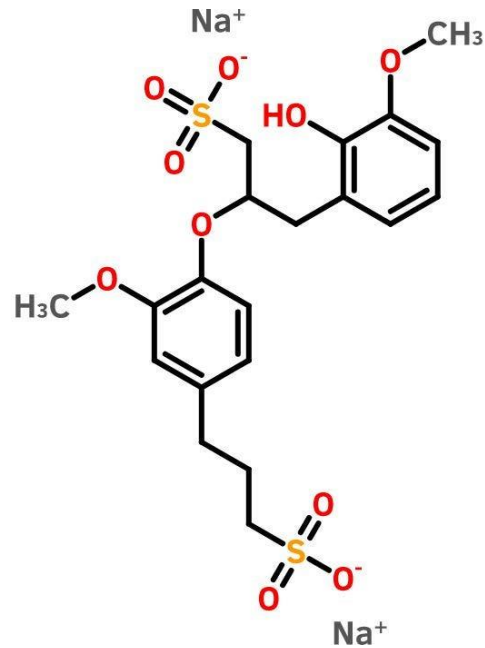
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AMINO ACID FORMULA STRUCTURE

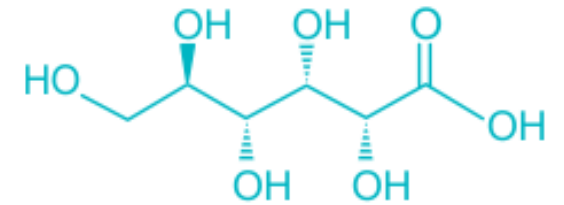


BYJU'S
The Learning App



Sodium Lignosulfonate

testbook



Structure of Gluconic Acid

Potassium Compatibility

- **Compatible:** with sulfate and neutral forms of Potassium
 - Potassium Sulfate K_2SO_4
 - Potassium Thiosulfate $K_2S_2O_3$
 - Potassium Chloride KCl
 - Potassium Acetate CH_3COOK
- Long term stability will depend on bicarbonates/alkalinity of water



Potassium Compatibility

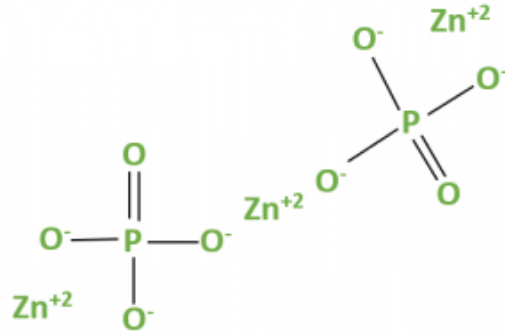
- **Incompatible:** with high pH forms of Potassium and Potassium Phosphates/Phosphites
 - Potassium Carbonate K_2CO_3
 - Potassium Phosphate K_3PO_4
 - Potassium Phosphite KH_2PO_3
- Carbonate increases pH as well HCO_3^-
 - Form insoluble carbonate salts
- High alkalinity = High OH^- anions
 - Form insoluble hydroxide salts



0-0-30

GUARANTEED ANALYSIS
Soluble Potash (K_2O).....30.00%
DERIVED FROM: Potassium Carbonate.

Phosphate Compatibility

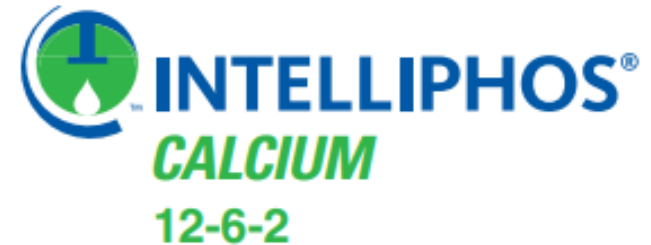


- **Incompatible:** with neutral ortho Phosphates (PO_4^{3-}) and Phosphites (PO_3^{3-})
- Potassium Phosphate K_3PO_4
- Monopotassium Phosphate (MKP) KH_2PO_4
- Monoammonium Phosphate (MAP) $\text{NH}_4\text{H}_2\text{PO}_4$
- Potassium Phosphite KH_2PO_3
- Phosphate salts are insoluble due to chain formation

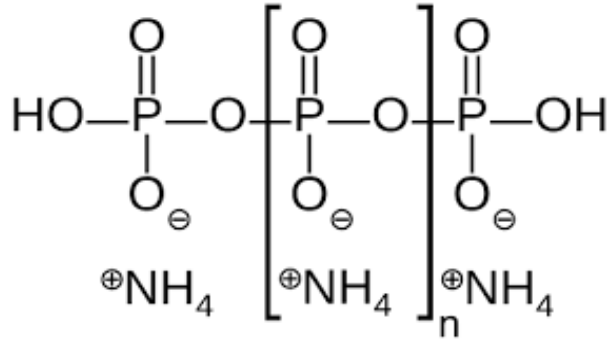


Phosphate Compatibility

- **Compatible:** with low pH (~2.0) phosphates
- Increased acidity (H^+) blocks interaction with phosphate anions
- Solution is so overcrowded with H^+ that the ions have no room to interact
- pH 8 to pH 2 = 1,000,000 more H^+



Polyphosphate Compatibility



- **Limited compatibility:** polyphosphate chains have the ability to complex metal cations
 - 1 qt micro to 10 gal 10-34-0
 - Agitation required

10-34-0
Liquid Ammonium Polyphosphate

 **TILL-IT[®]**
BACKBONE[®]
6-21-0

 **TILL-IT[®]**
LAUNCH
7-23-2

 **TILL-IT[®]**
GOLD-ZONE[®] ULTRA
6-24-6

Compatibility Aide

- **Works as a preventative tool**
- Increased acidity (H^+), increases solubility
- Decreases interactions with OH^- prevents formation of insoluble hydroxides
- As little as 8-16 oz per 50-100 gal water
- Calcium Chloride creates the buffering functionality
 - It is volatile



TRI-FOL[®]

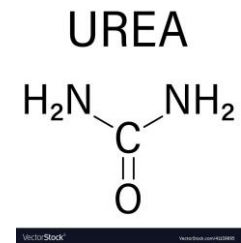
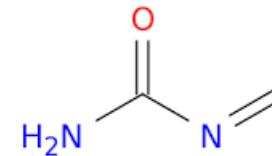
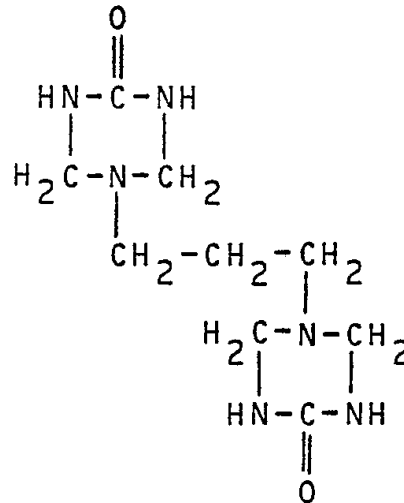
ACIDIFIER & BUFFERING AGENT



PRINCIPAL FUNCTIONING AGENTS:		%BY WT:
2-Hydroxy-1,2,3-Propanetricarboxylic Acid		25.0%
Calcium Chloride		9.0%
CONSTITUENTS INEFFECTIVE AS SPRAY ADJUVANT:		66.0%
TOTAL		100.0%

Nitrogen Compatibility

- **Compatible:** with all forms of Nitrogen
- Urea, Triazone Urea, Methylene Urea
 - Inert and not ionize in solution
 - Long term stability in slow-release Urea limited by high pH of solution.
- Nitrates provide needed acidity
- Ammonium Sulfate and Ammonium Thiosulfate



UAN-32

Urea Ammonium Nitrate Solution

32-0-0

GUARANTEED ANALYSIS

TOTAL NITROGEN (N).....	32.00%
7.75% Ammoniacal Nitrogen	
7.75% Nitrate Nitrogen	
16.50% Urea Nitrogen	

Derived from Ammonium Nitrate and Urea.



GUARANTEED ANALYSIS

Total Nitrogen (N)	30.00%
12.00% Urea Nitrogen	
18.00% Water Soluble Nitrogen*	

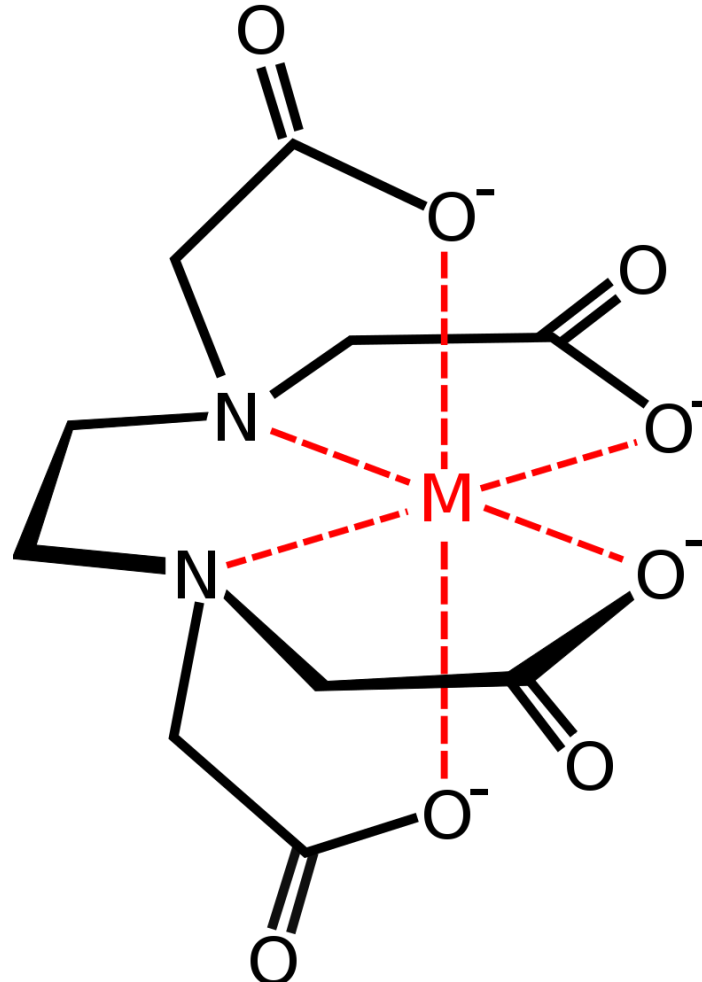
DERIVED FROM: Triazone, Methylene Urea and Urea.

EDTA Chelated Micros

- **Chelation:** an organic compound formed when a polydentate ligand bonds to a central metal cation
- Metal is “encapsulated” by dipotassium or diammonium EDTA complex
- **Compatible** with essentially everything

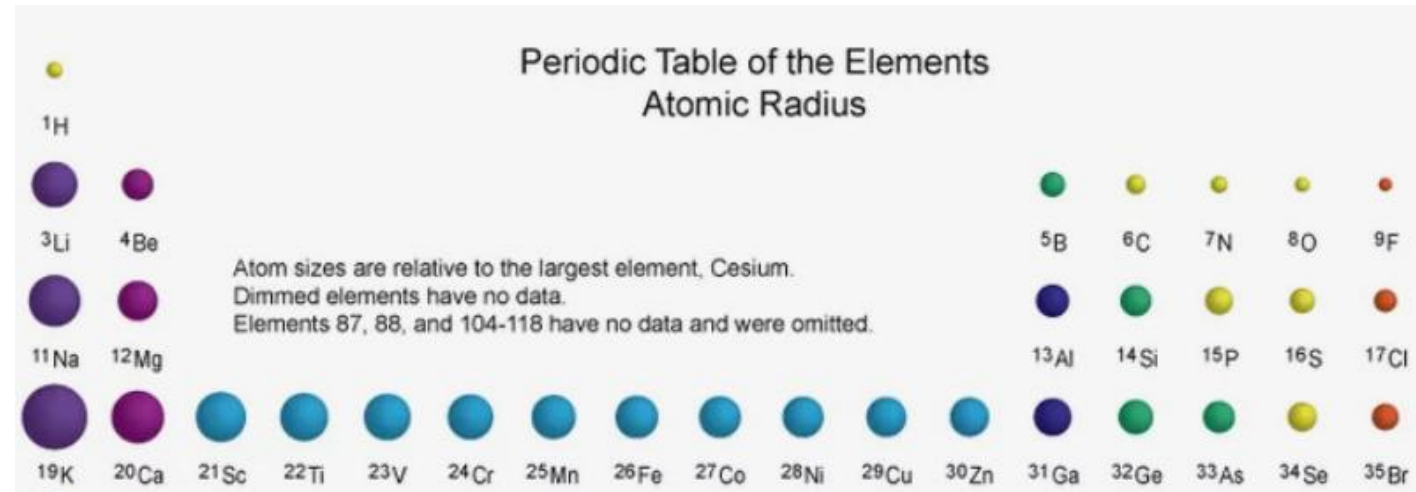


EDTA Complex



Exceptions

- Low pH (<2.0) will slowly deteriorate EDTA complex
- Calcium out competes Zinc for chelated position
 - Till-It Duo Zinc 9%
 - Free Ammonia slows down substitution
 - Ammonia is volatile, not permanent fix
- Boron will interact with Potassium at high rates
 - 1:1 rates not recommended
 - Cold weather will accelerate salt out



NPK Compatibility

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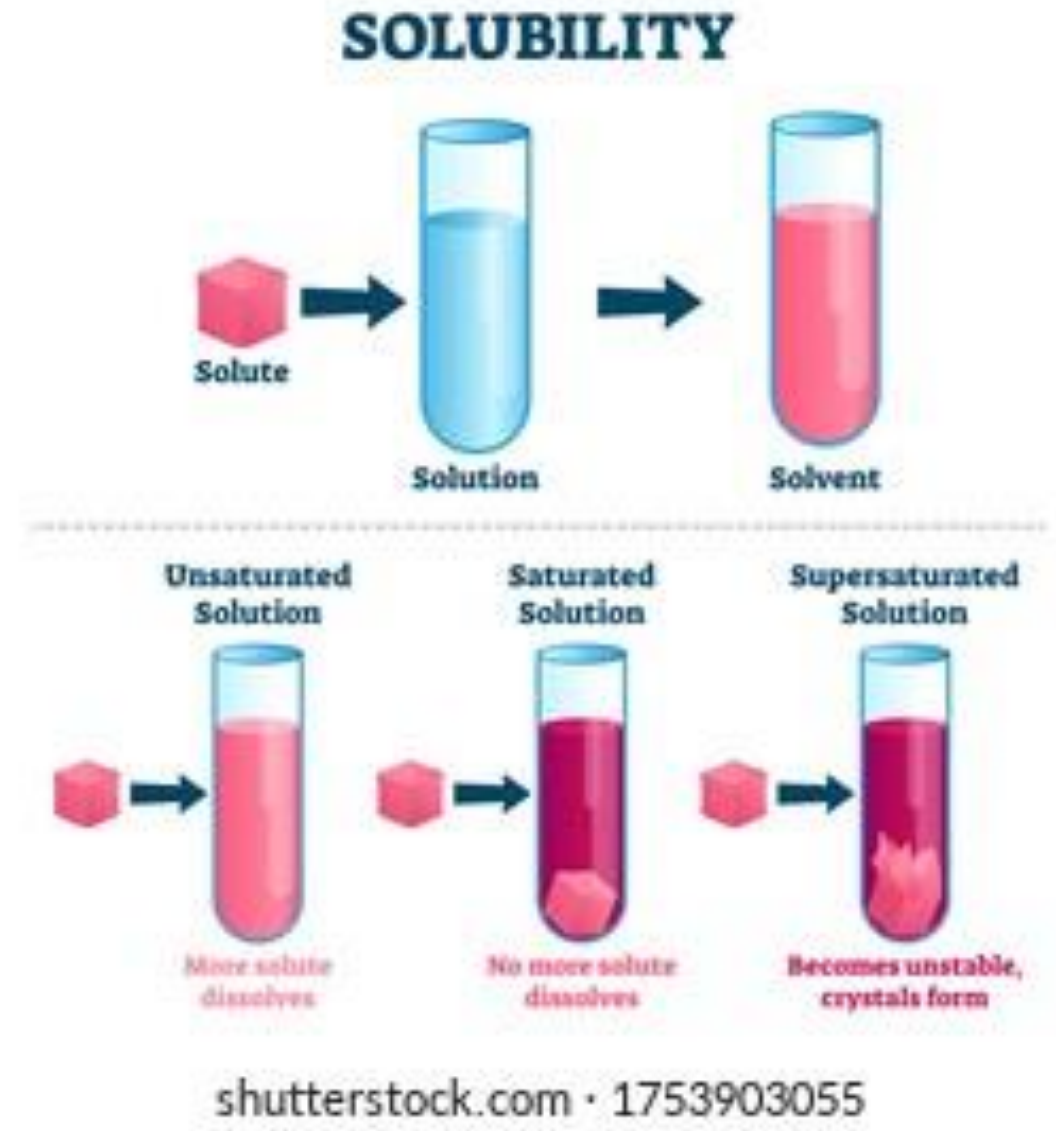


Solution Saturation

- refers to the point at which a solvent (usually water) can no longer dissolve more of a solute (such as a fertilizer), and any additional solute will remain undissolved

Tips to Prevent

- Water first: especially when mixing concentrated solutions
 - Avoid hot water unless needed for dry material
- Acidify water if needed
- Continuous agitation



Phosphate and Potassium Compatibility

Neutral Phosphates/Phosphites/Poly:

Compatible:

- Potassium Thiosulfate $K_2S_2O_3$
- Potassium Chloride KCl
- Potassium Carbonate K_2CO_3
- Potassium Acetate CH_3COOK
- Potassium Sulfate K_2SO_4

Limited compatibility:

- Potassium Acetate CH_3COOK
- 3:1 Poly to Acetate is stability maximum



Incompatibilities:

- Mostly seen due to saturation issues

Phosphate and Potassium Compatibility

Acidic Phosphates:



Limited Compatibility:

- Potassium Acetate CH_3COOK
- Potassium Sulfate K_2SO_4
 - Instability window between pH 4.5-6.0
 - Formation of MKP
- Potassium Carbonate K_2CO_3
 - Neutralization reaction will generate heat and foaming as CO_3 off gasses

Limited Compatibility:

- Potassium Chloride KCl
 - HCl will be formed through ionization and is very corrosive: stainless steel equipment required

Incompatibilities:

- Potassium Thiosulfate $\text{K}_2\text{S}_2\text{O}_3$
 - Thiosulfate decomposes at >5.0 pH.
- Mostly seen due to saturation issues

Phosphate and Nitrogen Compatibility

Neutral Phosphates, Phosphites and Poly

Compatible:

- Urea $\text{CO}(\text{NH}_2)_2$
- Ammonium Nitrate NH_4NO_3
- Ammonium Sulfate $(\text{NH}_4)_2\text{SO}_4$
- Ammonium Thiosulfate $(\text{NH}_4)_2\text{S}_2\text{O}_3$

Limited compatibility:

- Triazone and Methylene Urea
 - Slowly hydrolysis in neutral pH

Incompatible:

- Calcium Nitrate $\text{Ca}(\text{NO}_3)_2$
- Formation of Calcium Phosphate
- Rate dependent with Poly



Phosphate and Nitrogen Compatibility

Acidic Phosphate

Compatible:

- Urea $\text{CO}(\text{NH}_2)_2$
 - Slow degradation in pH >2
- Ammonium Nitrate NH_4NO_3
- Ammonium Sulfate $(\text{NH}_4)_2\text{SO}_4$
- Calcium Nitrate $\text{Ca}(\text{NO}_3)_2$

Incompatible:

- Ammonium Thiosulfate $(\text{NH}_4)_2\text{S}_2\text{O}_3$
 - Thiosulfate decomposes at >5.0 pH.
- Triazone and Methylene Urea
 - Acidic pH will rapidly hydrolyze polymers

Potassium and Nitrogen Compatibility

Neutral Potassium

Compatible:

- Urea $\text{CO}(\text{NH}_2)_2$
- Ammonium Sulfate $(\text{NH}_4)_2\text{SO}_4$
- Ammonium Thiosulfate $(\text{NH}_4)_2\text{S}_2\text{O}_3$

Limited Compatibility:

- Ammonium Nitrate NH_4NO_3
- Urea Ammonium Nitrate
- Calcium Nitrate $\text{Ca}(\text{NO}_3)_2$
 - Potassium Nitrate has high salt out temperature (2-0-8 or 10-0-4 max concentration)



- Triazone and Methylene Urea
- Slow hydrolysis in neutral pH

Incompatibilities:

- Mostly seen due to saturation issues

Potassium and Nitrogen Compatibility

High pH Potassium

Compatible:

- Triazone and Methylene Urea
- Urea $\text{CO}(\text{NH}_2)_2$

Limited Compatibility:

- Ammonium Thiosulfate $(\text{NH}_4)_2\text{S}_2\text{O}_3$
- Ammonium Nitrate NH_4NO_3
- Urea Ammonium Nitrate
 - Ammonia volatilizes at high pH



0-0-30

GUARANTEED ANALYSIS
Soluble Potash (K_2O).....30.00%
DERIVED FROM: Potassium Carbonate.

Incompatibilities:

- Calcium Nitrate $\text{Ca}(\text{NO}_3)_2$
- Calcium Carbonate/Calcium Hydroxide is formed
- Ammonium Sulfate $(\text{NH}_4)_2\text{SO}_4$
 - Potassium Sulfate is formed



New Product/Nutrio/Humic Compatibility

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GUARANTEED ANALYSIS

Magnesium (Mg)..... 5.00%

Derived from Magnesium Acetate.

- **Incompatible:** Potassium Carbonate, Ammonia



GUARANTEED ANALYSIS

Calcium (Ca)..... 6.00%

Derived from Calcium Acetate.

- **Incompatible:** Neutral Phosphate, Neutral Phosphite, Potassium Carbonate, Ammonia

	Nutralis Magnesium	Nutralis Calcium	
3-18-18			*Required vigorous agitation
10-34-0			
0-0-30 Pot Carb			
KTS			
ATS			
UAN 32			
Calcium Nitrate			
Till-It ReKoil			
Foli-Gro Kilo			
Intelliphos 32			*Required vigorous agitation
Maxset 31			
TerraLux			
Ndemand 30L			
Foli-Gro M7			
Till-It 707			
Foli-Gro Ca-Zn			
FG Tidalwave			
FG Hightide			
PN Calcium			
Botanic 8-0-0			
Employ			
Puric FC			
Puric Salute			
Puric Prime			
Puric			

50 gal Water
5 gal Fertilizer
2 qt Acetate



GUARANTEED ANALYSIS

Total Nitrogen (N) 5.00%
5.00% Water Soluble Nitrogen
Derived from Soy Protein Hydrolysate.

- **Limited compatibility:** Phosphate and Potassium without any water
- **Incompatible:** High Phosphate/Potassium without any water

	No H2O	8 gal H2O
3-18-18	Yellow	Green
10-34-0	Yellow	Green
0-0-30 Pot Carb	Yellow	Green
KTS	Yellow	Green
ATS	Green	Green
UAN 32	Green	Green
Calcium Nitrate	Green	Green
Till-It ReKoil	Yellow	Green
Foli-Gro Kilo	Yellow	Green
Intelliphos 32	Green	Green
Maxset 31	Red	Green
TerraLux	Green	Green
NDemand 30L	Green	Green
Foli-Gro M7	Green	Green
Till-It 707	Green	Green
Foli-Gro Ca-Zn	Green	Green
FG Tidalwave	Green	Green
FG Hightide	Green	Green
Employ	Green	Green
PN Calcium	Green	Green
Botanic 8-0-0	Green	Green
Puric FC	Green	Green
Puric Salute	Green	Green
Puric Prime	Green	Green
Puric	Green	Green

5 gal Fertilizer
1 pt StimTide



Nutrio Compatibility/Viability

- **Compatible:** Water based formula is compatible in all solutions
- Sensitive to extreme pHs (>2 and >12)
- Sensitive to actives
- Bacteria will begin to grow in other organic products after 1-2 weeks
 - Humics, Amino Acids, Seaweeds

Storage Requirements

- Preferably store below 85F, but not strictly required
- Freezing temperatures do not seem to affect bacterial spores
- **AVOID** direct sunlight as UV exposure will kill bacteria
- Confirmed 2-month viability once mixed with fertilizer



Humic Acid Compatibility



0-0-2

- **Low tier compatibility**
- **Compatible:** Highly diluted solutions, neutral to basic pH
- **Incompatible:** High salt solutions, acidic solutions, Calcium



1-0-2

- **Mid tier compatibility**
- **Compatible:** Semi-diluted solutions, neutral to basic pH
- **Incompatible:** Acidic solutions, Calcium



0-0-3

- **Top tier compatibility**
- **Compatible:** Concentrated solutions, acidic to basic pH, Calcium
- **Limited compatibility:** Highly diluted solutions

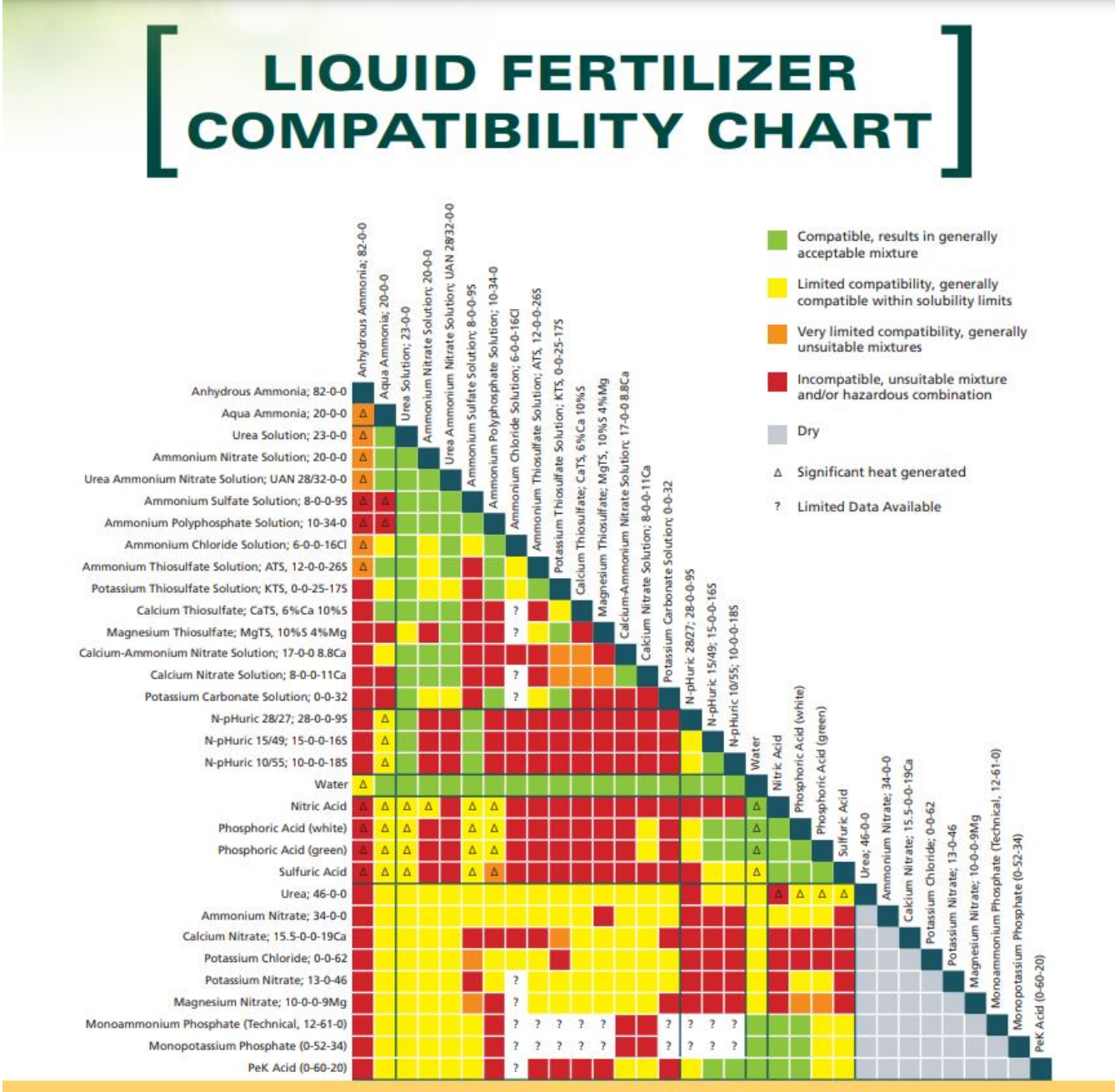


Jar Testing

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LIQUID FERTILIZER COMPATIBILITY CHART





COMPOUND SOLUBILITY

for Compounds in Common Liquid Fertilizers

Also applies to
Cu & Mn

TRAINING

		Cations							
		Acids H ⁺	Ammonium NH ₄ ⁺	Potassium K ⁺	Calcium Ca ²⁺	Magnesium Mg ²⁺	Zinc Zn ²⁺	Iron Fe ²⁺	Sodium Na ⁺
Anions	Acetate C ₂ H ₃ O ₂ ⁻	Acetic Acid	Ammonium Acetate	Potassium Acetate	Calcium Acetate	Magnesium Acetate	Zinc Acetate	Iron Acetate	Sodium Acetate
	Carbonate CO ₃ ²⁻	Carbonic Acid	N/A	Potassium Carbonate	Calcium Carbonate	Magnesium Carbonate	Zinc Carbonate	Iron Carbonate	Sodium Carbonate
	Bicarbonate HCO ₃ ⁻	N/A	Ammonium Bicarbonate	Potassium Bicarbonate	Calcium Bicarbonate	Magnesium Bicarbonate	N/A	N/A	Sodium Bicarbonate
	Hydroxide OH ⁻	Water	Ammonium Hydroxide	Potassium Hydroxide	Calcium Hydroxide	Magnesium Hydroxide	Zinc Hydroxide	Iron Hydroxide	Sodium Hydroxide
	Nitrate NO ₃ ⁻	Nitric Acid	Ammonium Nitrate	Potassium Nitrate	Calcium Nitrate	Magnesium Nitrate	Zinc Nitrate	Iron Nitrate	Sodium Nitrate
	Oxide O ²⁻	N/A	N/A	Potassium Oxide	Calcium Oxide	Magnesium Oxide	Zinc Oxide	Iron Oxide	Sodium Oxide
	Phosphate PO ₄ ³⁻	Phosphoric Acid	Ammonium Phosphate	Potassium Phosphate	Calcium Phosphate	Magnesium Phosphate	Zinc Phosphate	Iron Phosphate	Sodium Phosphate
	Sulfate SO ₄ ²⁻	Sulfuric Acid	Ammonium Sulfate	Potassium Sulfate	Calcium Sulfate	Magnesium Sulfate	Zinc Sulfate	Iron Sulfate	Sodium Sulfate
	Thiosulfate S ₂ O ₃ ²⁻	N/A	Ammonium Thiosulfate	Potassium Thiosulfate	Calcium Thiosulfate	Magnesium Thiosulfate	N/A	N/A	Sodium Thiosulfate
	Citrate C ₆ H ₅ O ₇ ³⁻	Citric Acid	Ammonium Citrate	Potassium Citrate	Calcium Citrate	Magnesium Citrate	Zinc Citrate	Iron Citrate	Sodium Citrate
	Chloride Cl ⁻	Hydrochloric Acid	Ammonium Chloride	Potassium Chloride	Calcium Chloride	Magnesium Chloride	Zinc Chloride	Iron Chloride	Sodium Chloride
	Molybdate MoO ₄ ²⁻	Molybdic Acid	Ammonium Molybdate	Potassium Molybdate	Calcium Molybdate	Magnesium Molybdate	Zinc Molybdate	Iron Molybdate	Sodium Molybdate
	Borate BO ₃ ²⁻	Boric Acid	Ammonium Borate	Potassium Borate	Calcium Borate	Magnesium Borate	Zinc Borate	Iron Borate	Sodium Borate

Soluble
Conditionally Soluble
Insoluble

● Common Ingredient in Fertilizers

This guide is based on mixes done at full concentration at temps 60-70°F. Always read and follow handling instructions on product packaging.



WILBUR-ELLIS.

v 02

IV ACADEMY®



Jar Test Set-up

10 gal UAN 32

10 gal 3-18-18

TN	Urea-N	NH4-N	NO3-N	P205	K2O
17.10	8.02	5.31	3.77	9.25	9.25

UAN 32

3-18-18

GA	Density (Lb/gal)	Lbs	%	Double Up
10	11.07	110.7	48.6	97.2
10	11.70	117.0	51.4	102.8
		227.7		

Steps:

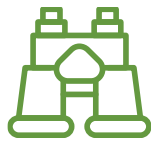
1. Convert volumes to gallons
2. Multiply gallons by density of product to get total pounds
3. Add total pounds and determine percent weight
4. Use percentage values as grams for a 100 g sample



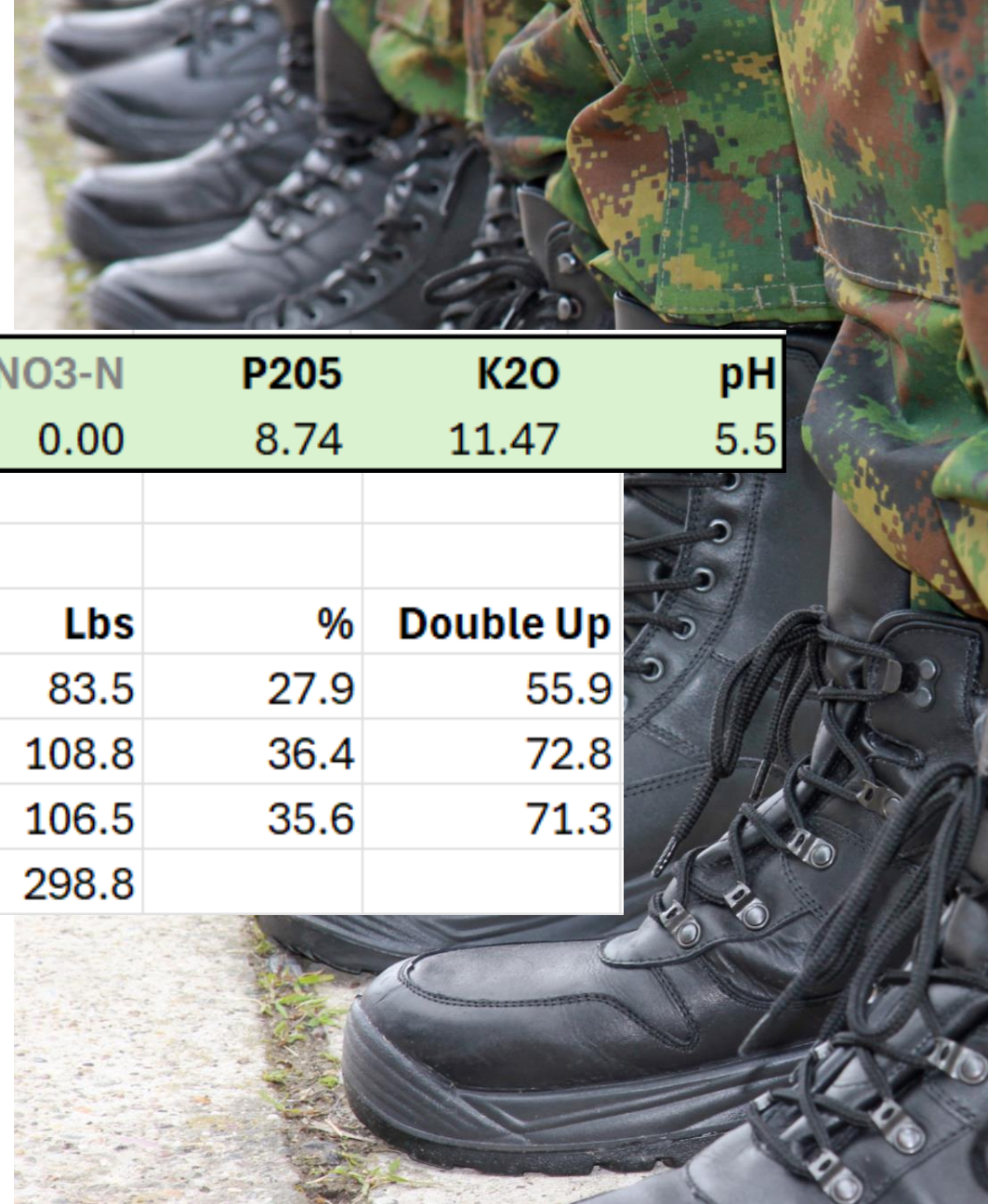
5 gal Water	TN	Urea-N	NH4-N	NO3-N	P205	K2O
10 gal UAN 32	14.45	6.78	4.49	3.18	7.82	7.82
10 gal 3-18-18						
	GA	Density (Lb/gal)	Lbs	%	Double Up	
Water	5	8.35	41.7	15.5	31.0	
UAN 32	10	11.07	110.7	41.1	82.2	
3-18-18	10	11.70	117.0	43.4	86.9	
			269.4			

10 gal Water	TN	Urea-N	NH4-N	NO3-N	P205	K2O
10 gal UAN 32	12.51	5.87	3.89	2.76	6.77	6.77
10 gal 3-18-18						
	GA	Density (Lb/gal)	Lbs	%	Double Up	
Water	10	8.35	83.5	26.8	53.6	
UAN 32	10	11.07	110.7	35.6	71.2	
3-18-18	10	11.70	117.0	37.6	75.2	
			311.2			



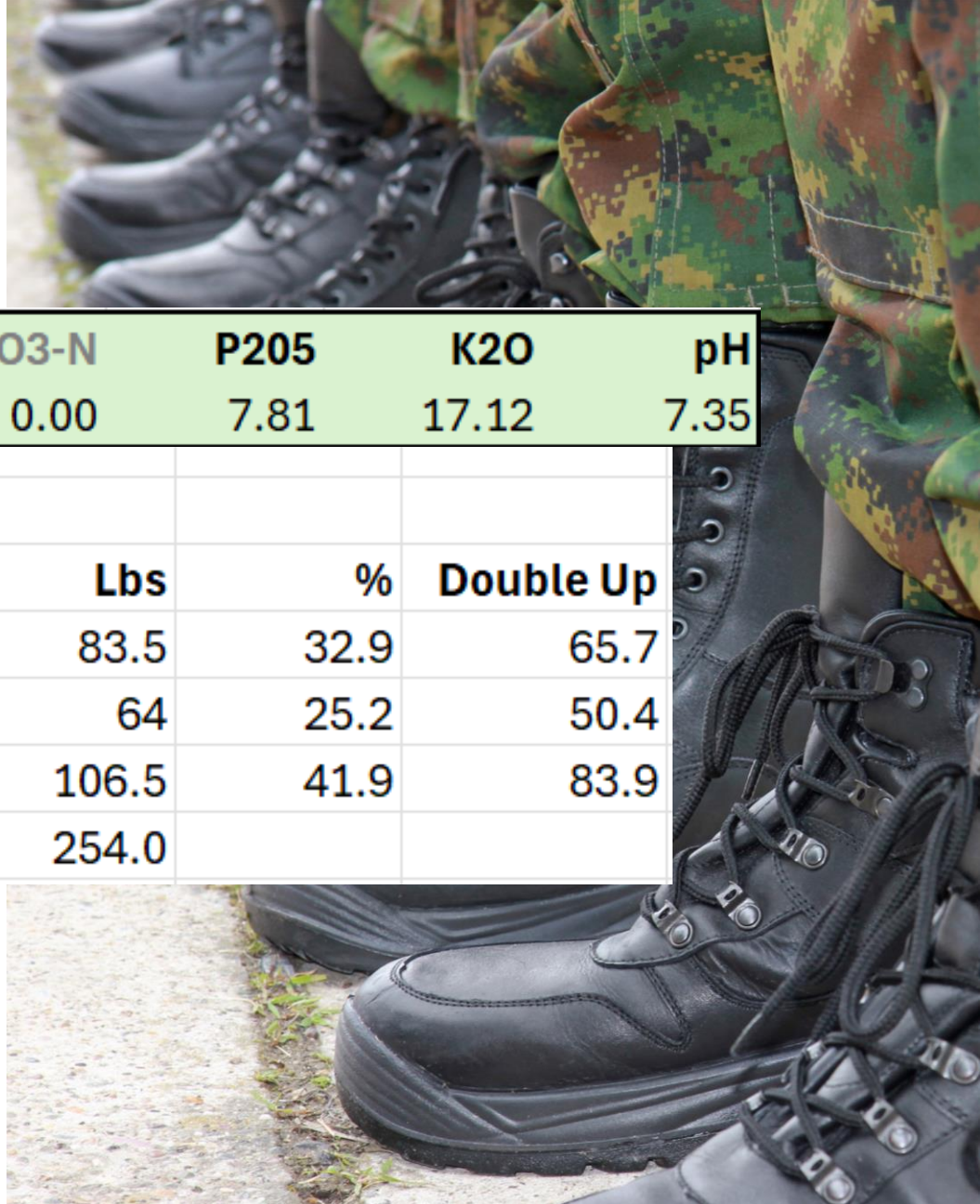


Jar Test #2



	TN	Urea-N	NH4-N	NO3-N	P205	K2O	pH
10 gal Water	0.00	0.00	0.00	0.00	8.74	11.47	5.5
10 gal Intelliphos 32							
10 gal Foli-Gro Kilo							
	GA	Density (Lb/gal)		Lbs	%	Double Up	
Water	10	8.35		83.5	27.9	55.9	
Intelliphos 32	10	10.88		108.8	36.4	72.8	
Foli-Gro Kilo	10	10.65		106.5	35.6	71.3	
				298.8			



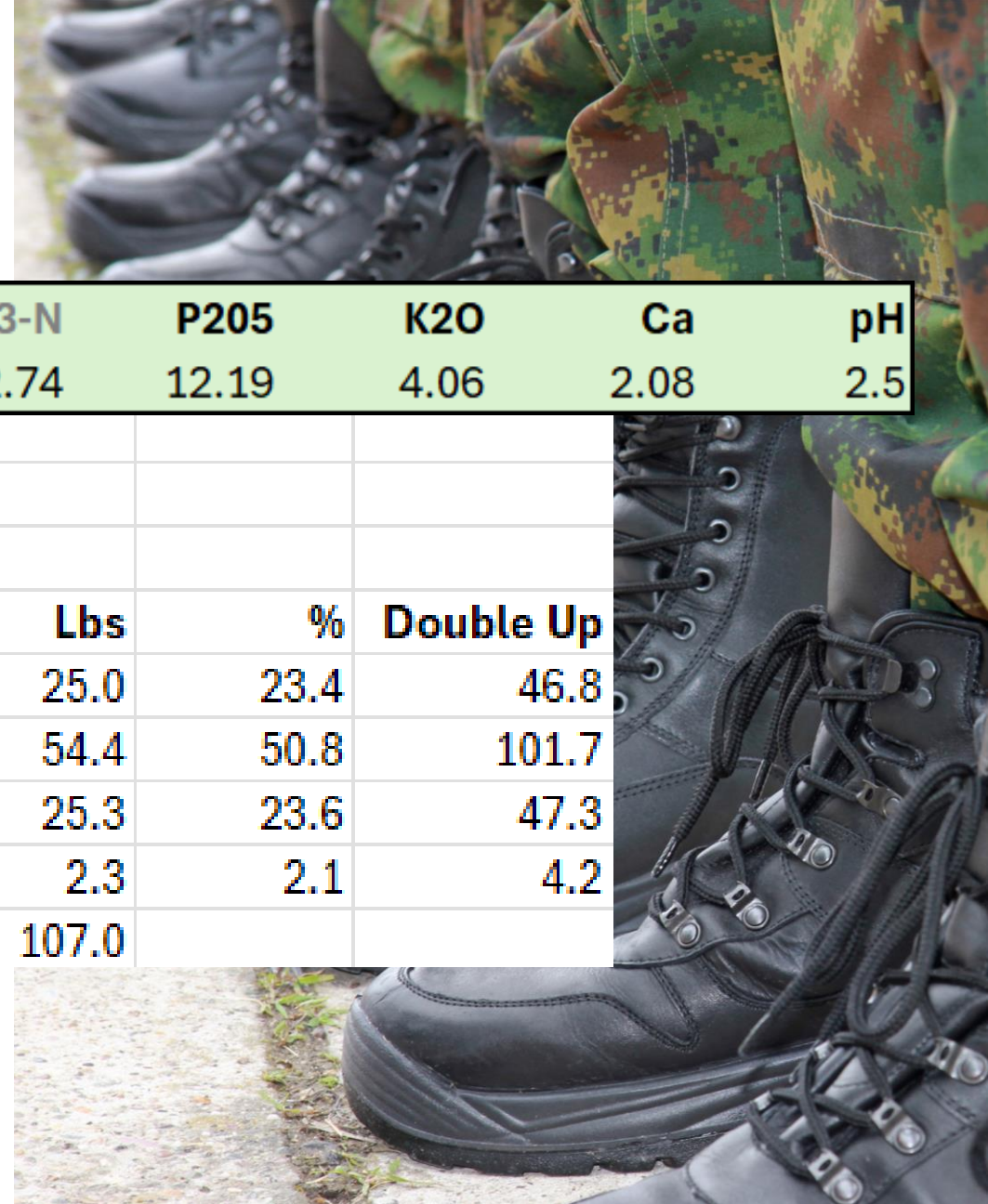


10 gal Water	TN	Urea-N	NH4-N	NO3-N	P205	K2O	pH
5 gal Maxset 31	0.00	0.00	0.00	0.00	7.81	17.12	7.35
10 gal Foli-Gro Kilo							
	GA	Density (Lb/gal)		Lbs	%	Double Up	
Water	10	8.35		83.5	32.9	65.7	
Maxset 31	5	12.80		64	25.2	50.4	
Foli-Gro Kilo	10	10.65		106.5	41.9	83.9	
				254.0			



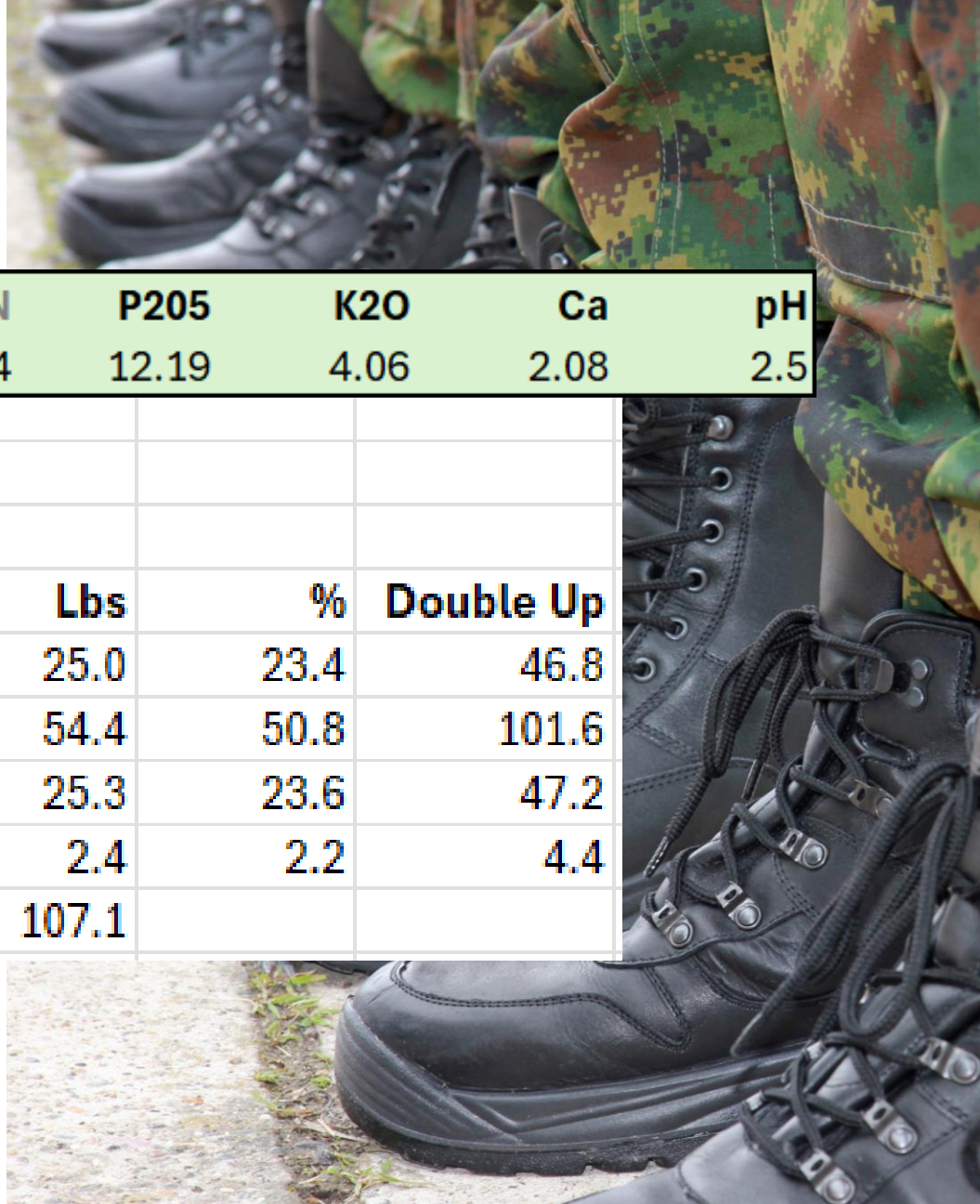


Jar Test #3



	TN	Urea-N	NH4-N	NO3-N	P205	K2O	Ca	pH
3 gal Water	4.01	0.00	1.27	2.74	12.19	4.06	2.08	2.5
5 gal Intelliphos 32								
2 gal CAN-17								
1 qt Puric Prime								
	GA	Density (Lb/gal)	Lbs	%	Double Up			
Water	3	8.35	25.0	23.4	46.8			
Intelliphos 32	5	10.88	54.4	50.8	101.7			
CAN-17	2	12.64	25.3	23.6	47.3			
Puric Prime	0.25	9.07	2.3	2.1	4.2			
			107.0					





	TN	Urea-N	NH4-N	NO3-N	P205	K2O	Ca	pH
3 gal Water	4.01	0.00	1.27	2.74	12.19	4.06	2.08	2.5
5 gal Intelliphos 32								
2 gal CAN-17								
1 qt Puric Salute								
	GA	Density (Lb/gal)		Lbs	%	Double Up		
Water	3	8.35		25.0	23.4	46.8		
Intelliphos 32	5	10.88		54.4	50.8	101.6		
CAN-17	2	12.64		25.3	23.6	47.2		
Puric Salute	0.25	9.5		2.4	2.2	4.4		
				107.1				





Jar Test #4

5 gal Water	TN	Urea-N	NH4-N	NO3-N	P205	K2O
15 gal Till-It Rekoil	1.20	0.00	1.20	0.00	4.20	11.79
5 gal Till-It Backbone						
2 qt Foli-Gro M-7						
	GA	Density (Lb/gal)	Lbs	%	Double Up	
Water	5	8.35	41.7	16.0	32.0	
Till-It Rekoil	15	10.79	161.85	62.1	124.2	
Till-It Backbone	5	10.43	52.2	20.0	40.0	
Foli-Gro M-7	0.5	10	5.0	1.9	3.8	
			260.7			



GUARANTEED ANALYSIS

Total Nitrogen (N)	0.50%
0.50% Nitrate Nitrogen	
Magnesium (Mg)	1.00%
0.50% Chelated Magnesium	
Sulfur (S)	2.00%
Iron (Fe)	1.00%
1.00% Chelated Iron	
Manganese (Mn)	1.00%
0.50% Chelated Manganese	
Zinc (Zn)	1.00%
0.50% Chelated Zinc	

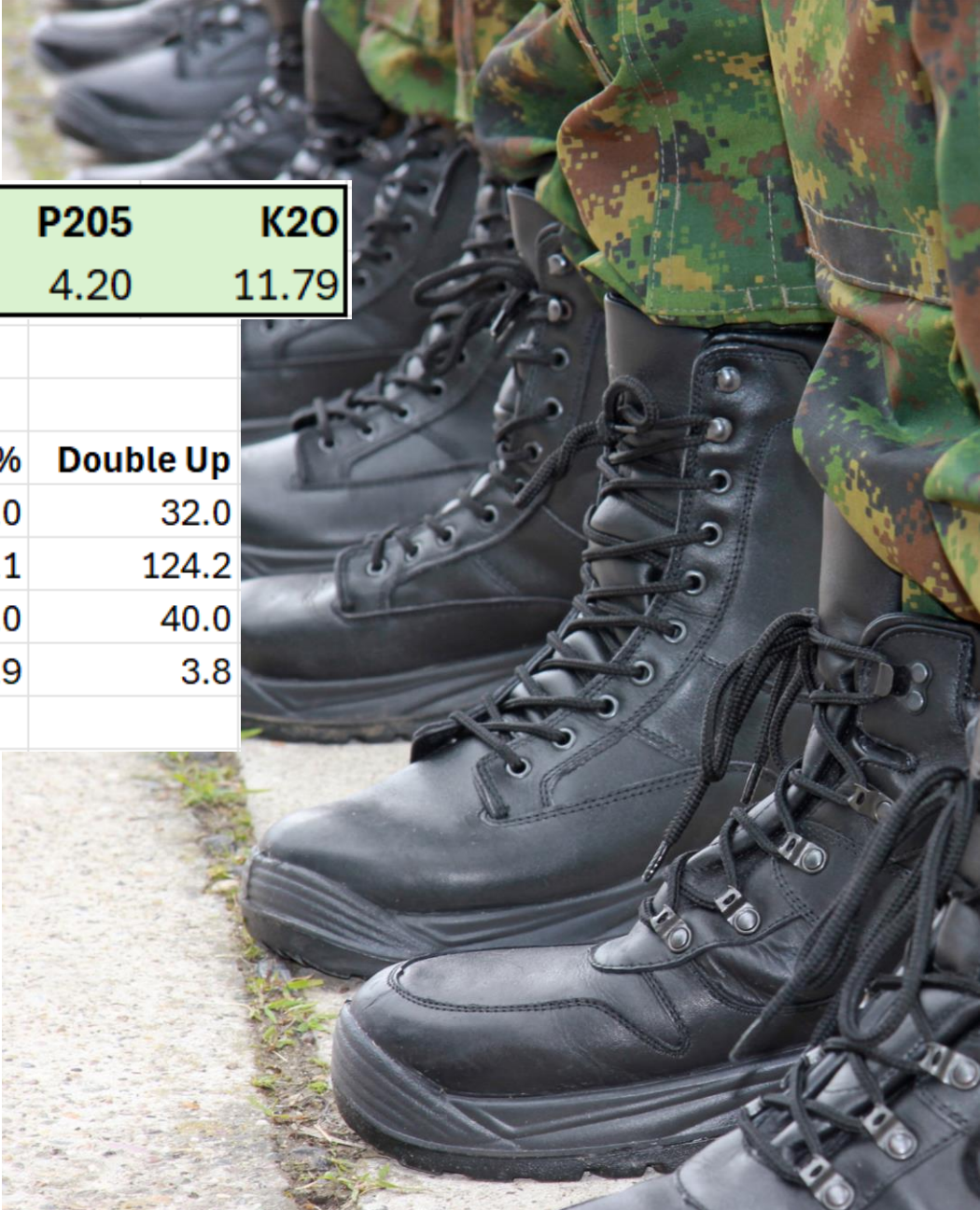


WILBUR-ELLIS.

DERIVED FROM: Magnesium Sulfate, Ferrous Sulfate, Manganese Nitrate, and Zinc Sulfate. Chelated with citric acid.

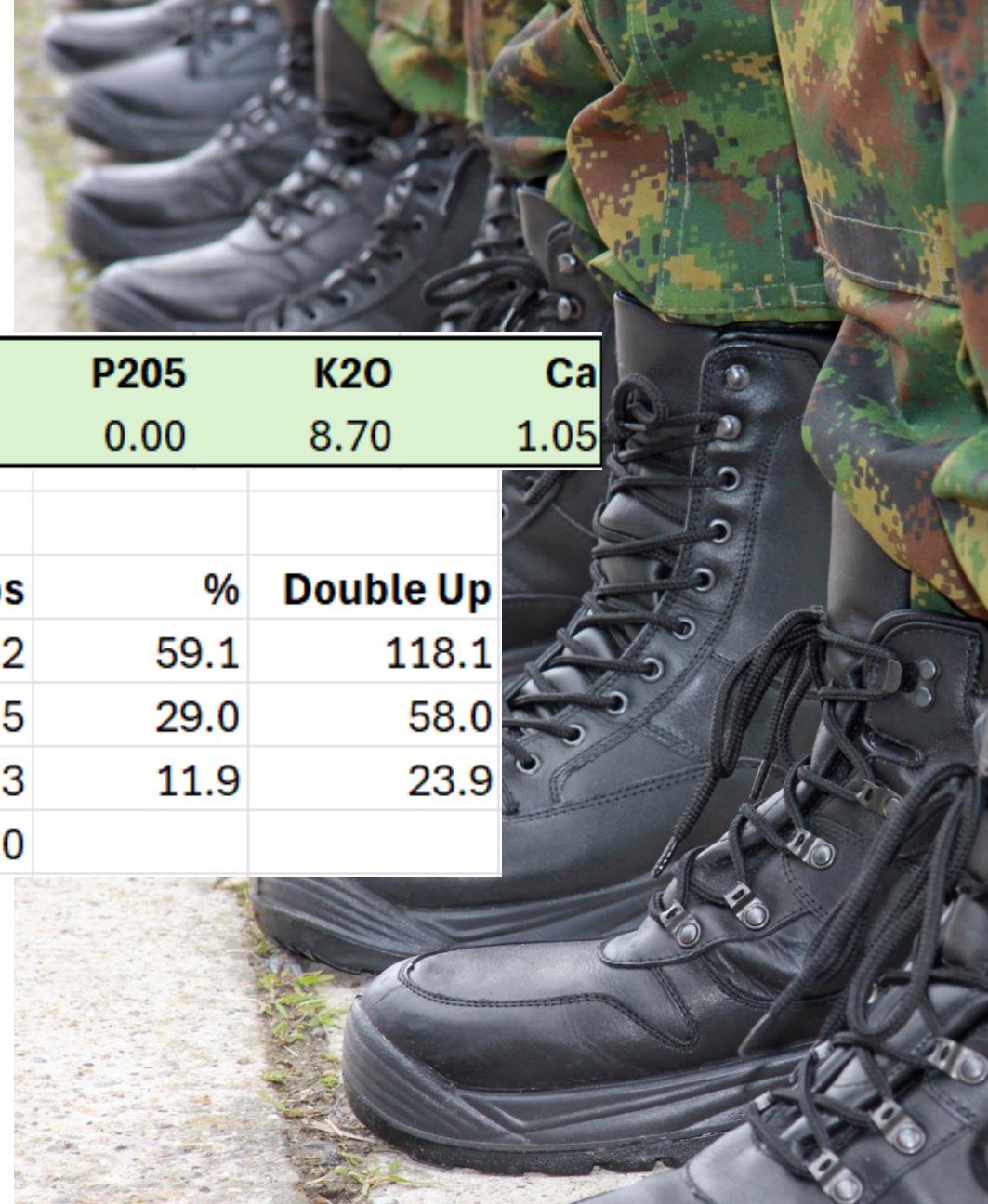


ADVANCED AGRONOMY ACADEMY®





Jar Test #5



	TN	Urea-N	NH4-N	NO3-N	P205	K2O	Ca
15 gal Water	2.03	0.00	0.64	1.38	0.00	8.70	1.05
5 gal 0-0-30							
2 gal CAN-17							
	GA	Density (Lb/gal)		Lbs	%	Double Up	
Water	15	8.35		125.2	59.1	118.1	
0-0-30	5	12.30		61.5	29.0	58.0	
CAN-17	2	12.64		25.3	11.9	23.9	
				212.0			



	TN	Urea-N	NH4-N	NO3-N	P205	K2O	Ca
15 gal Water	2.11	0.00	0.67	1.44	0.00	6.27	1.09
5 gal Foli-Gro Kilo							
2 gal CAN-17							
	GA	Density (Lb/gal)	Lbs	%	Double Up		
Water	15	8.35	125.2	61.4	122.9		
Foli-Gro Kilo	5	10.65	53.25	26.1	52.3		
CAN-17	2	12.64	25.3	12.4	24.8		
			203.7				





Questions ??

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