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Biological effect of Polyhalite on tea production

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Contents Overview

Introduction

K/Mg in tea production

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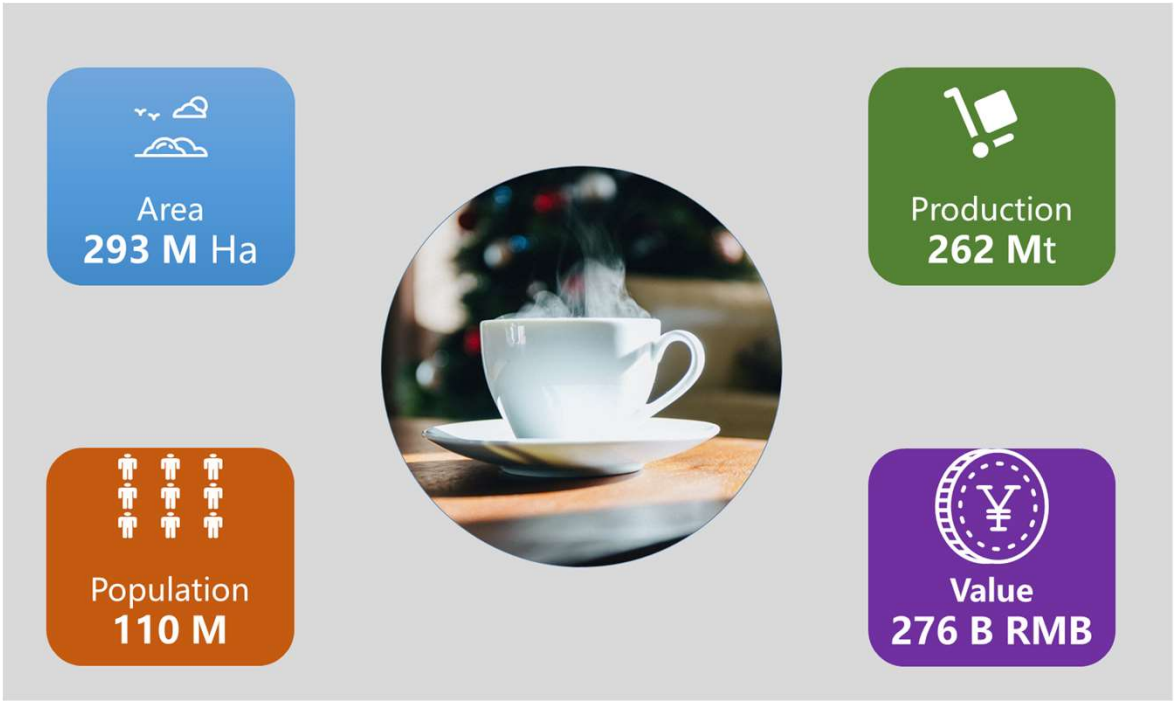
Tea production in China

- China is the largest country for tea production

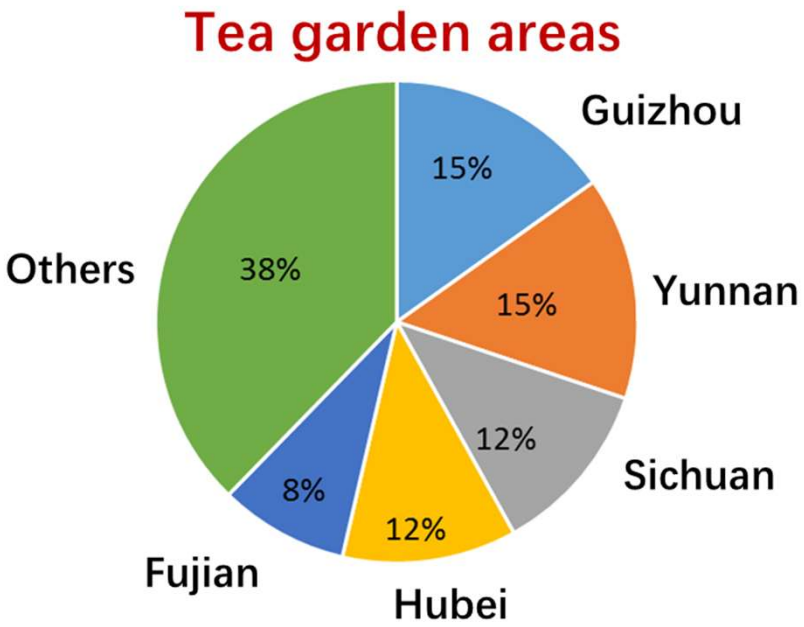


China Tea Marketing Association

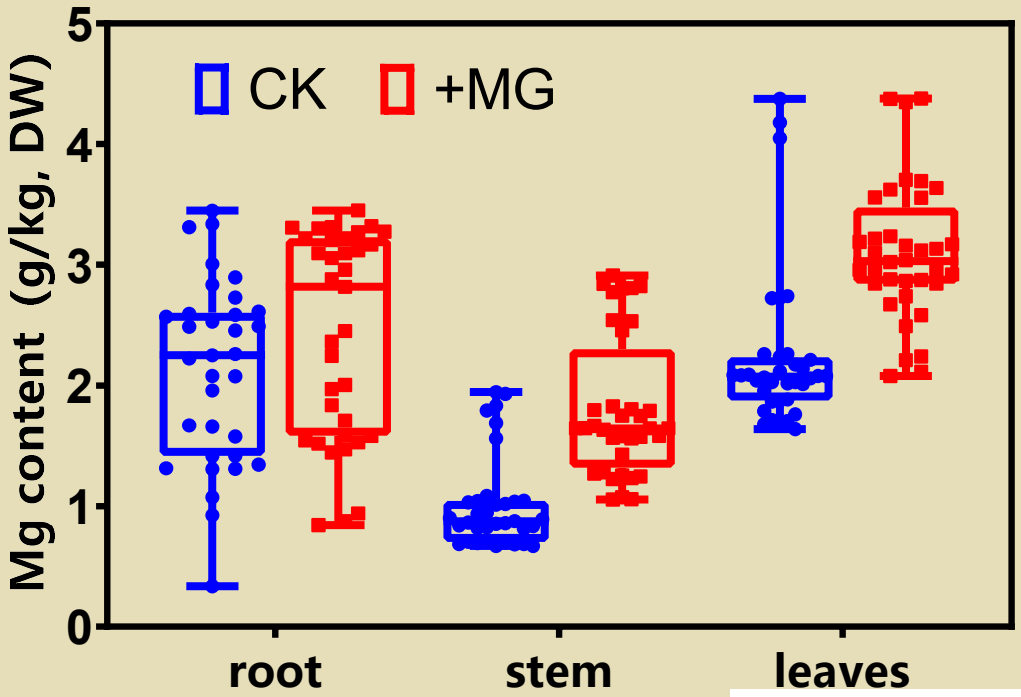
- ~3 M ha, 65%
- 262 M ton, 42%
- 110 M, ~10%
- 276 Billion RMB

- Tea plantation is common in southern China
  - ~19 provinces, even in parts of Tibet and Shanxi

- Most tea trees are planted in southwestern China
  - Southwestern China accounts for >40% plantation areas

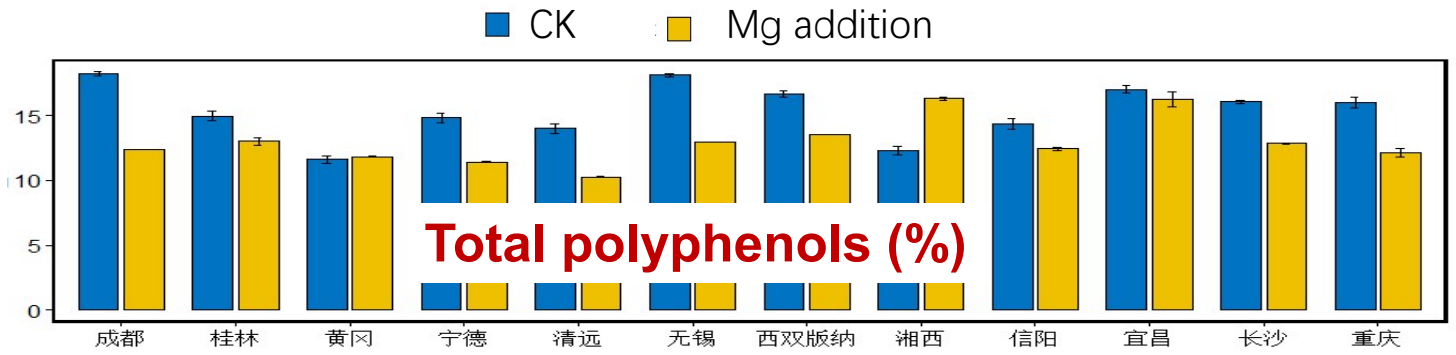


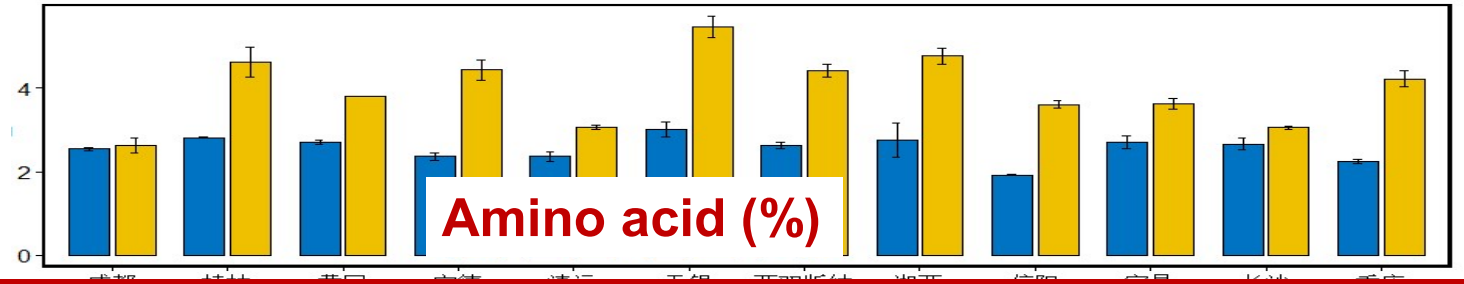
National Bureaus of Statistics



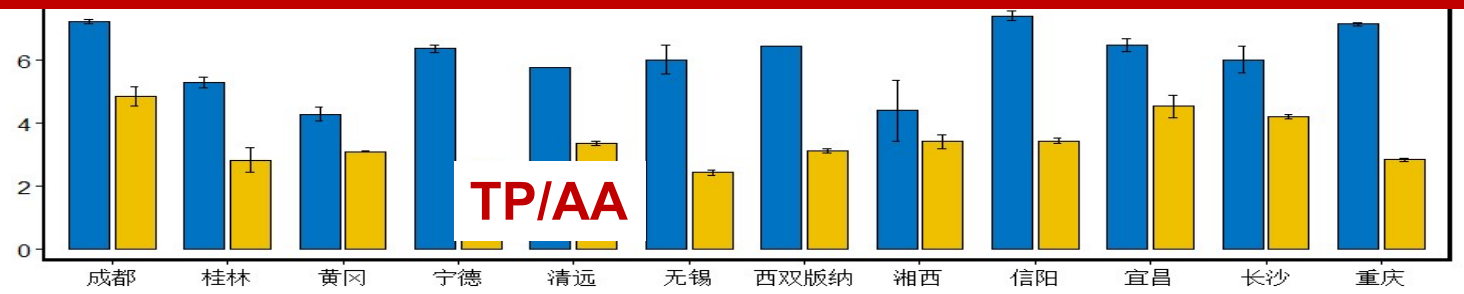
Zhang and Ruan, 201

Mg nutrition is crucial for leaf health, and applying Mg increased the Mg concentration in tea root, stem and leaves.





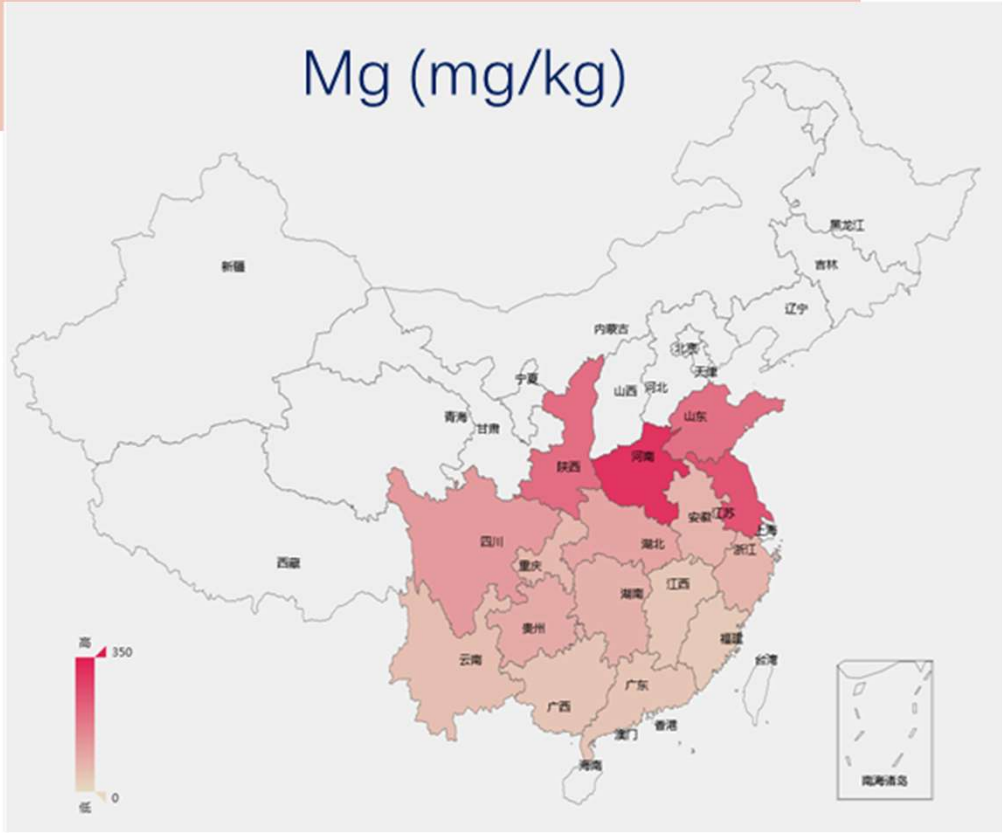
Applying Mg fertilizer improved the green tea quality



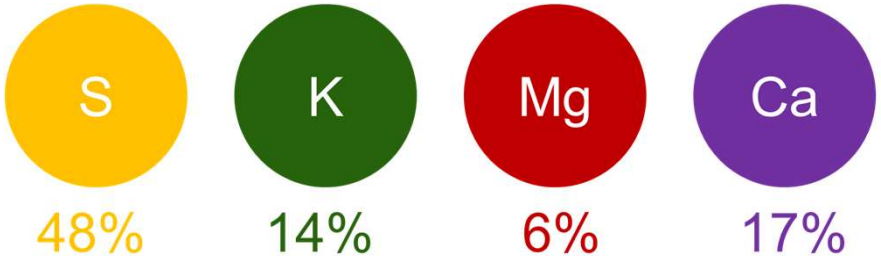
Zhang and Ruan, 2019

Most tea plantation soil is deficient in Mg

- Mg deficiency is common in tea plantation regions
  - 38% Tea gardens <40 mg/kg

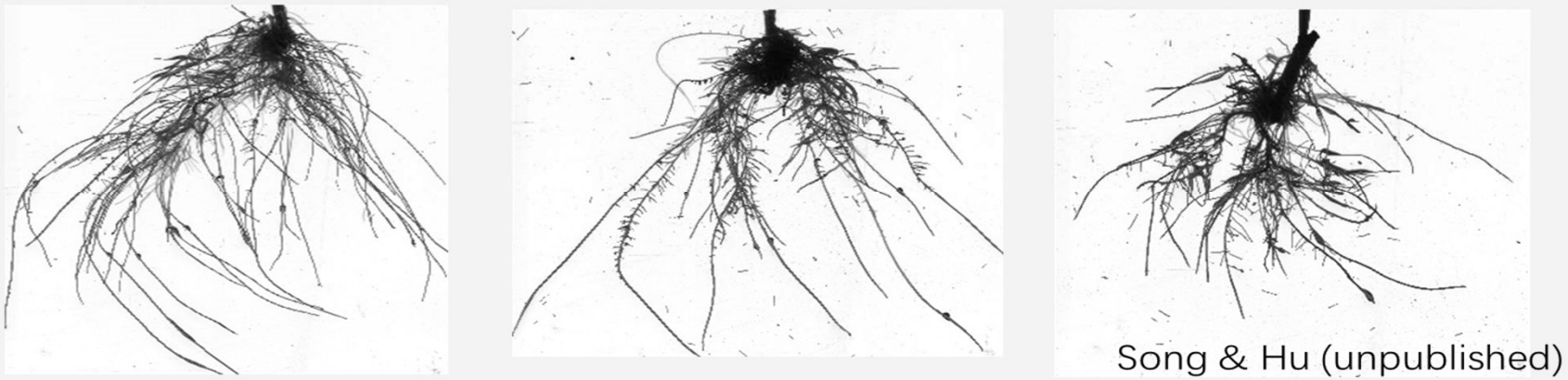


Supplying Mg is essential in tea plantation



- **Polyhalite contains K, Mg, essential for tea quality.**
- **17% CaO content may be harmful to tea growth.**

Root growth inhibited under high Ca^{2+}



Song & Hu (unpublished)

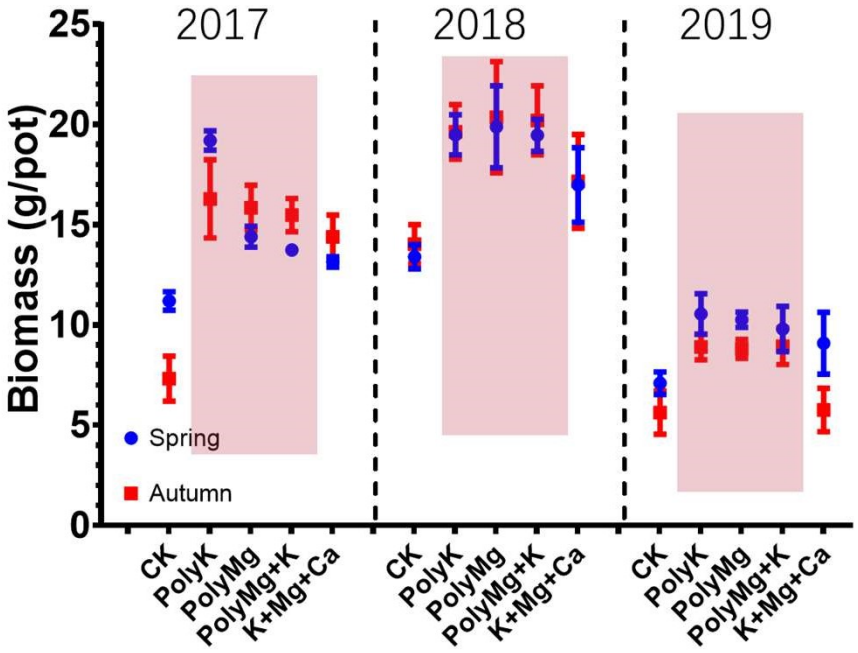
Objectives

- Whether polyhalite can inhibit tea growth due to its Ca?
- Is there any difference between Polyhalite and chemical K/Mg on tea production? (biomass and quality response)
- How about long-term use of polyhalite on soil condition (K, Mg, Ca, pH)
- Can polyhalite plays a interaction effect between N and Mg?

red clay soil (pH 5.3, SOC 0.81%, TN 0.08%, AP 0.6 mg/kg, AK 71.9 mg/kg, AMg 26.6 mg/kg)
N: 56 mg/kg (4 splits in Oct. March, May, August)
P: 56 mg/kg
K: 56 mg/kg
Mg: 12 mg/kg

Code	Comments	K (mg/kg)	Mg (mg/kg)	Ca (mg/kg)
CK	Blank	0	0	0
PolyK	Polyhalite according to K	56	22	79.95
polyMg	Polyhalite according to Mg	29	12	40.89
PolyMg+K	PolyMg, additional SOP	56	12	40.89
K+Mg+Ca	SOP, $MgSO_4 \cdot H_2O$, $CaSO_4$	56	12	60.00

Biomass

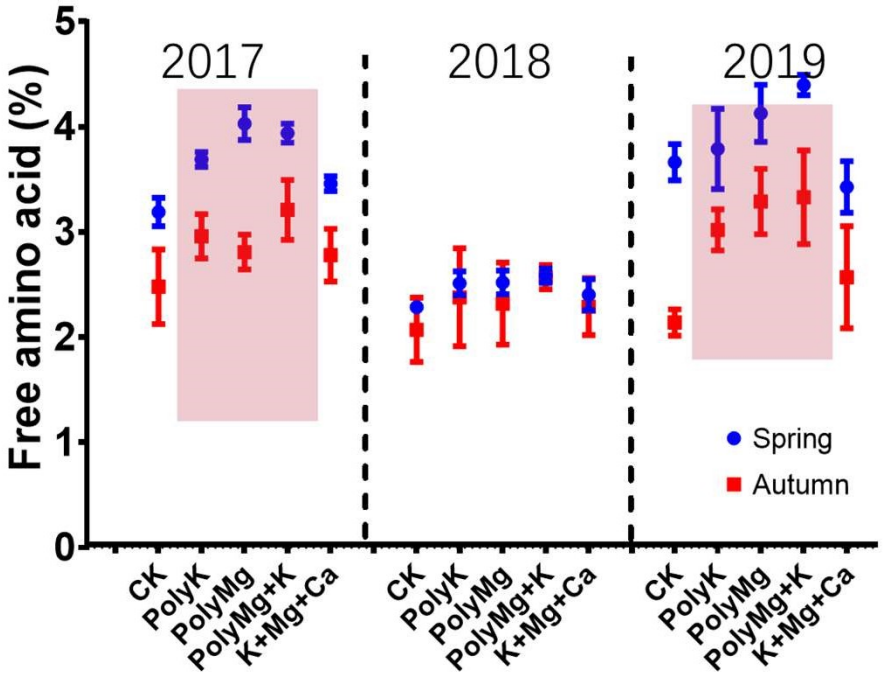


Treatment	Mean of 6 harvest Biosmass (g/pot)		
CK	9.78 c		
PolyK	**15.68 a**		
PolyMg	14.93 a		
PolyMg+K	14.6 a		
K+Mg+K	12.75 b		
ANOVA	**DF**	**MS**	**P value**
Interaction	20	7.103	P<0.0001
Treatments	4	134.2	P<0.0001
Seasons	5	377.3	P=0.38

Quality?

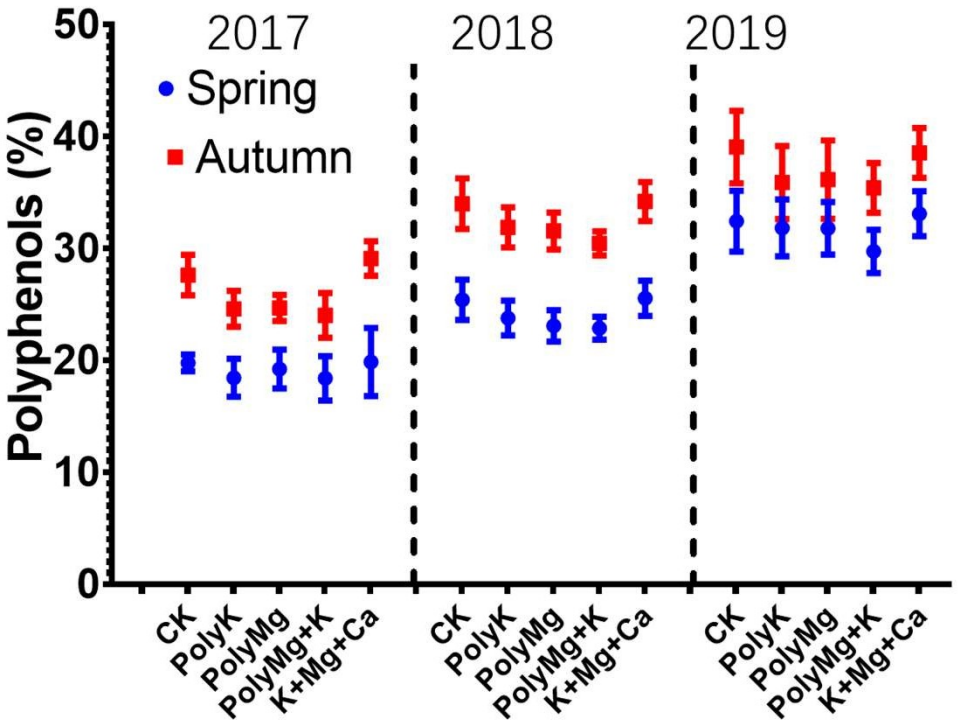
- Amino acid (fresh taste)
- Polyphenols (astrictive taste)
- Caffeine (health)
- Water extracts (soluble content)

- Spring tea has higher free amino acid concentration
- The beneficial effect of Polyhalite was weaker in spring, but stronger in autumn as the trial continued.



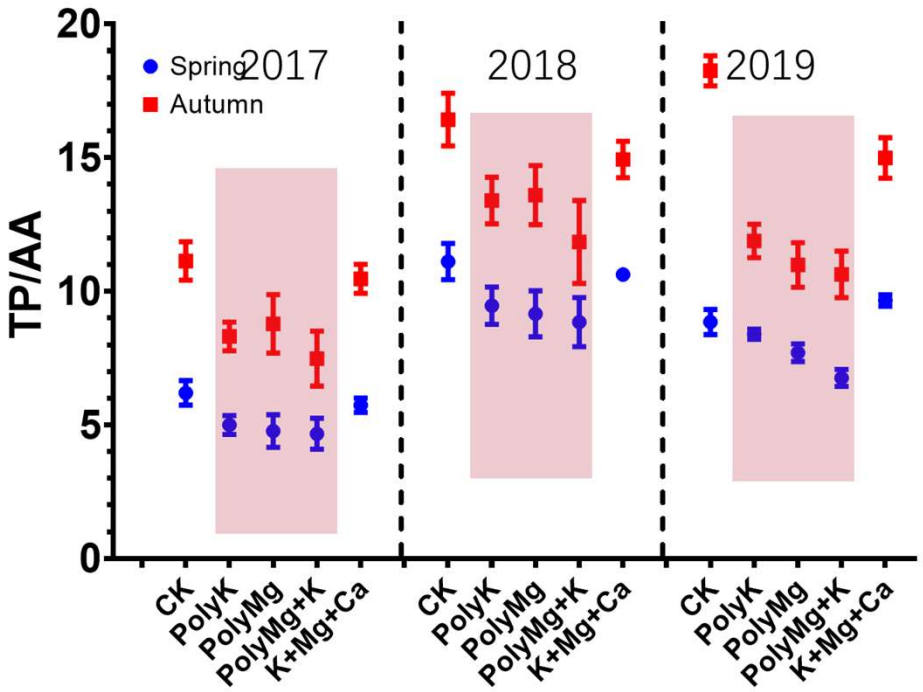
Treatment	Mean of 6 harvest Amino Acid content (%)		
CK	2.64 c		
PolyK	3.06 ab		
PolyMg	3.18 ab		
PolyMg+K	**3.34 a**		
K+Mg+Ca	2.82 bc		
ANOVA	**DF**	**MS**	**P value**
Interaction	20	7.103	<0.0001
Treatments	4	134.2	<0.0001
Seasons	5	377.3	0.94

Total polyphenols contents were lower under polyhalite addition, but insignificantly

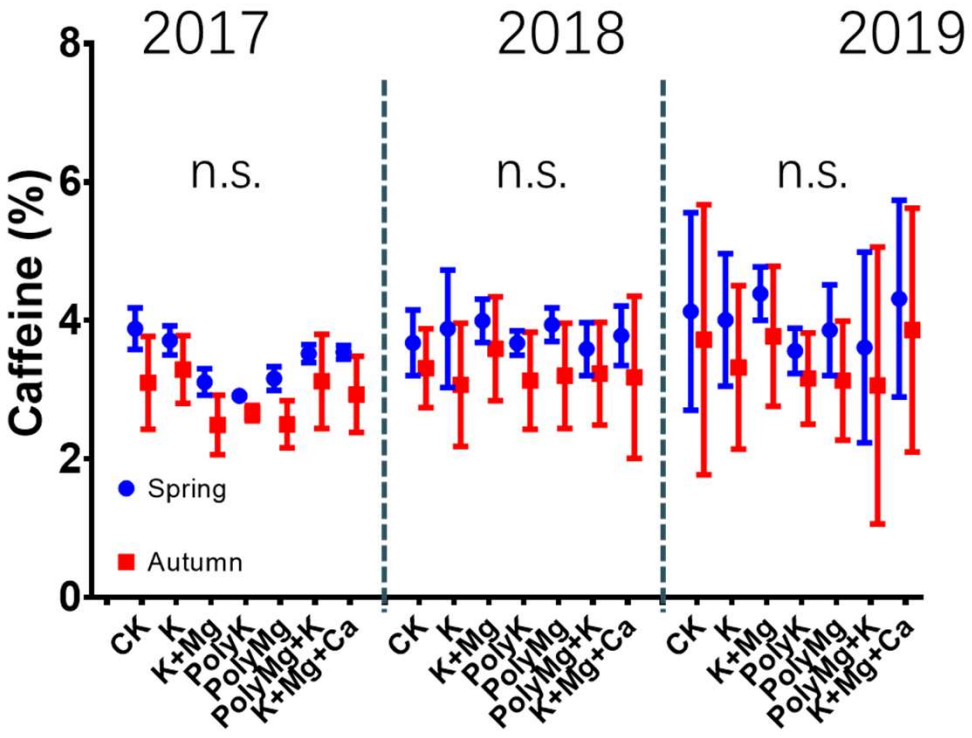


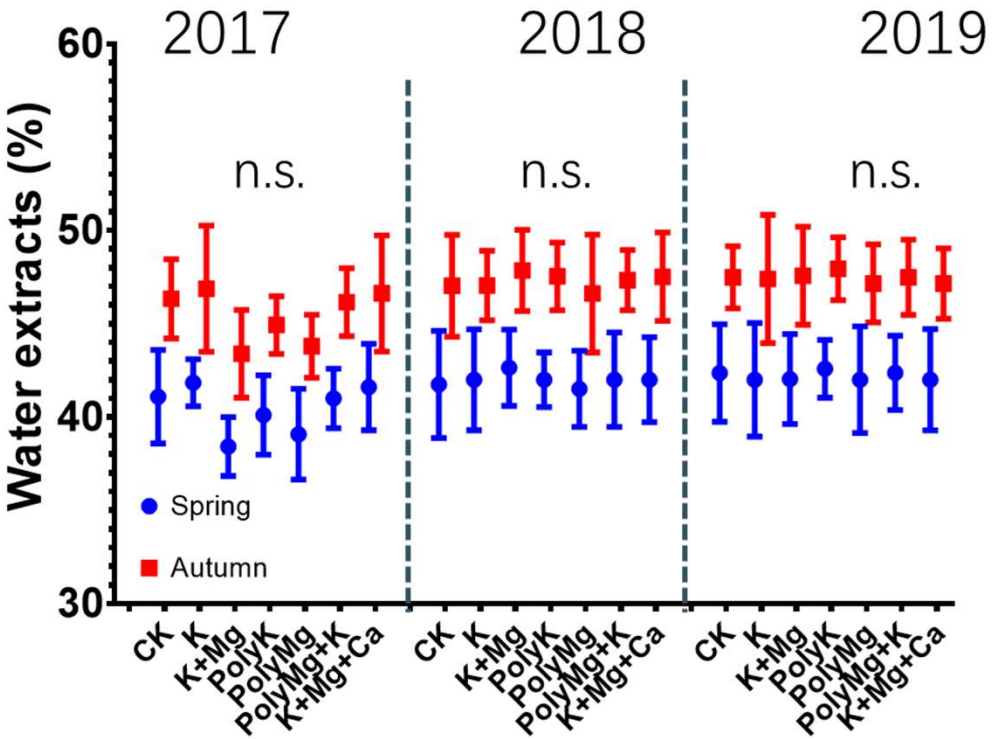
Treatment	Mean of 6 harvest Polyphenols (%)		
CK	29.71 n.s.		
PolyK	27.73		
PolyMg	27.74		
PolyMg+K	26.81		
K+Mg+Ca	30.05		
ANOVA	**DF**	**MS**	**P value**
Interaction	20	1.825	P>0.9999
Treatments	4	47.08	P=0.0348
Seasons	5	844.9	P<0.0001

- Polyhalite **reduced** the ratio between polyphenols and amino acid contents
- The beneficial effect is more significant in autumn tea

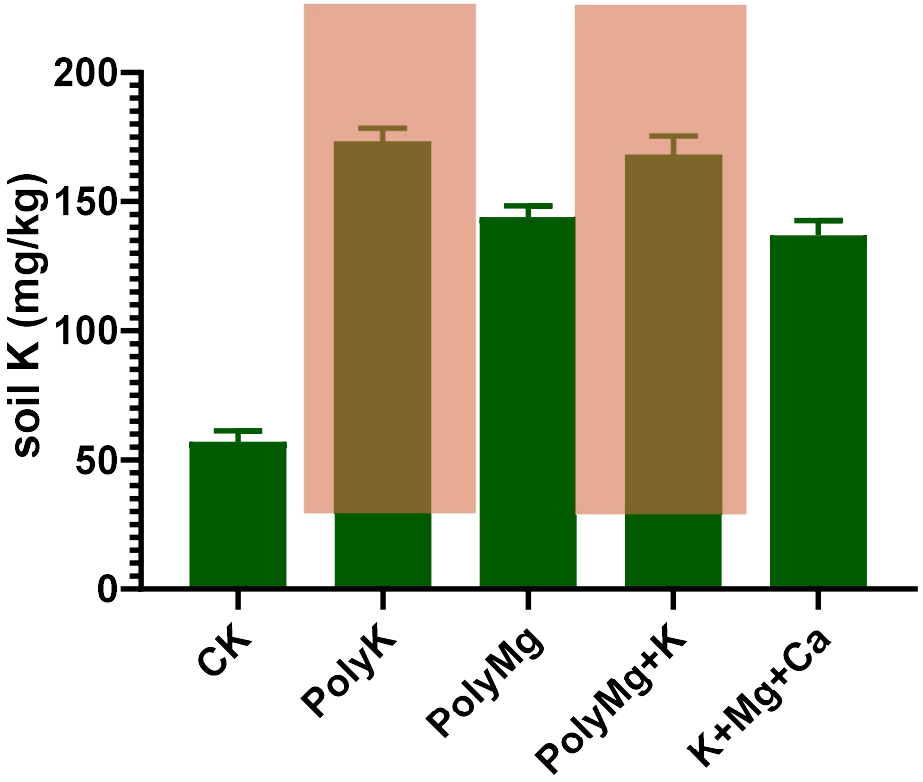


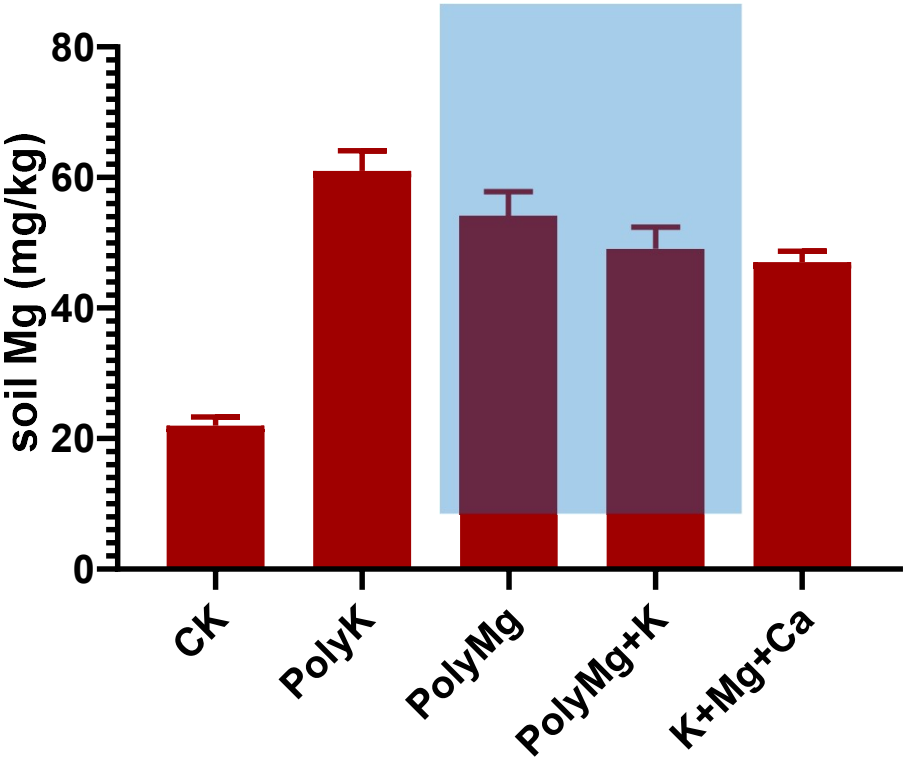
Treatment	Mean of 6 harvest TP/AA		
CK	11.99a		
PolyK	9.41b		
PolyMg	9.17b		
PolyMg+K	8.37b		
K+Mg+Ca	11.07a		
ANOVA	**DF**	**MS**	**P value**
Interaction	20	4.111	P=0.0200
Treatments	4	52.88	P<0.0001
Seasons	5	213.8	P<0.0001



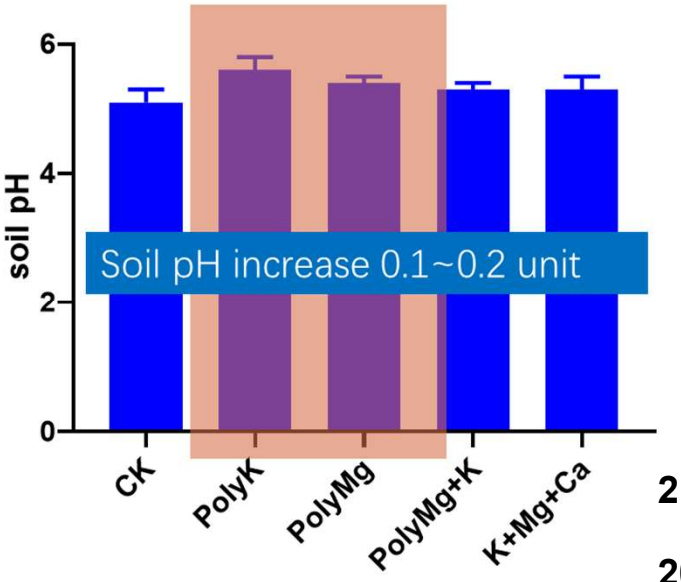


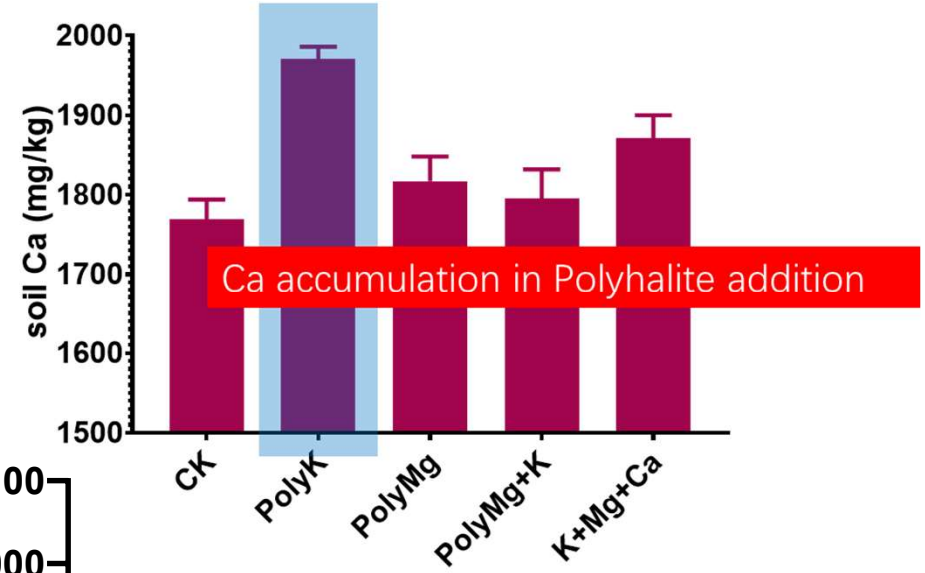
- Spring tea has higher caffeine, but less water extracted matter
- The effect between treatments was insignificant.

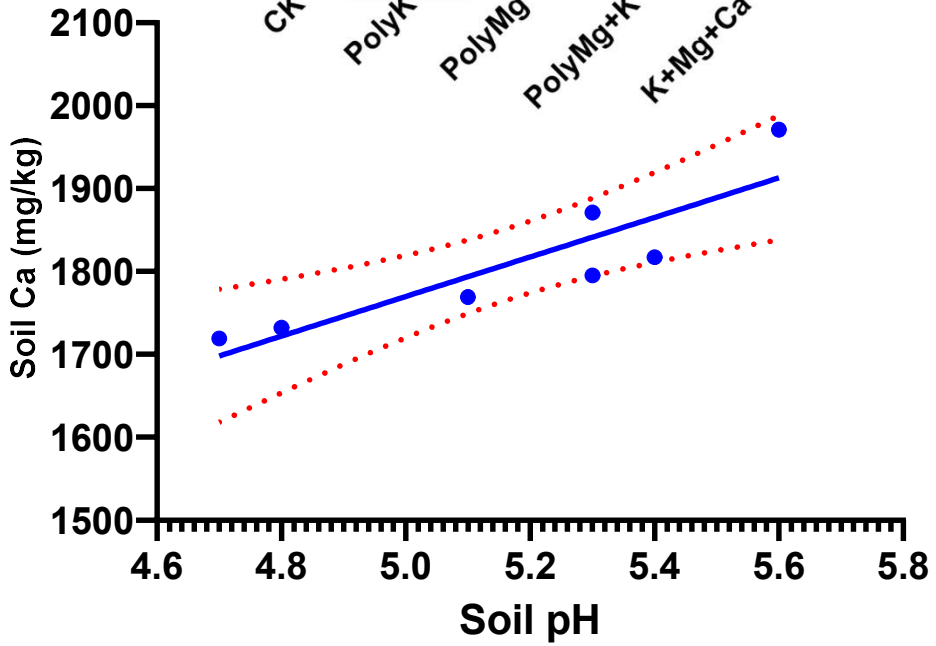




- With same amount K/Mg input, Polyhalite can remain more in the soil after 3 years


soil pH
6
4
2
0
Soil pH increase 0.1~0.2 unit
CK
PolyK
PolyMg
PolyMg+K
K+Mg+Ca


soil Ca (mg/kg)
2000
1900
1800
1700
1600
1500
Ca accumulation in Polyhalite addition
CK
PolyK
PolyMg
PolyMg+K
K+Mg+Ca

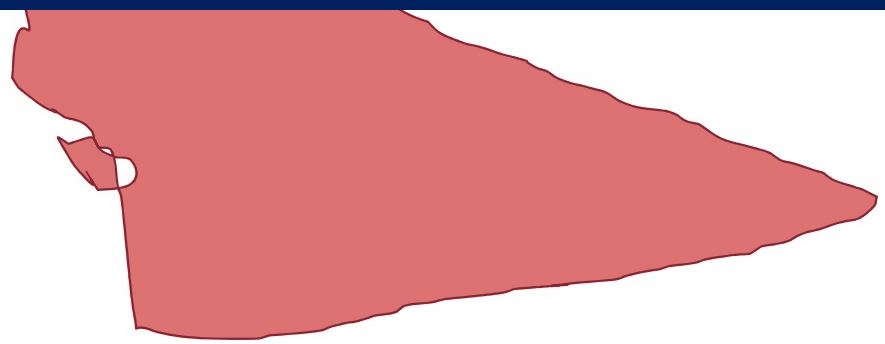

Soil Ca (mg/kg)
2100
2000
1900
1800
1700
1600
1500
4.6
4.8
5.0
5.2
5.4
5.6
5.8
Soil pH

Summary of the pot trial

- Polyhalite fertilizer can be used as K/Mg fertilizers in tea, no negative effect by its Ca addition
- Polyhalite showed a significant effects on biomass stimulation
- Polyhalite has a positive effect on reducing TP/AA
- Polyhalite can remain more K/Mg in the soil than chemical K/Mg fertilizer and also increase pH

Field Trial

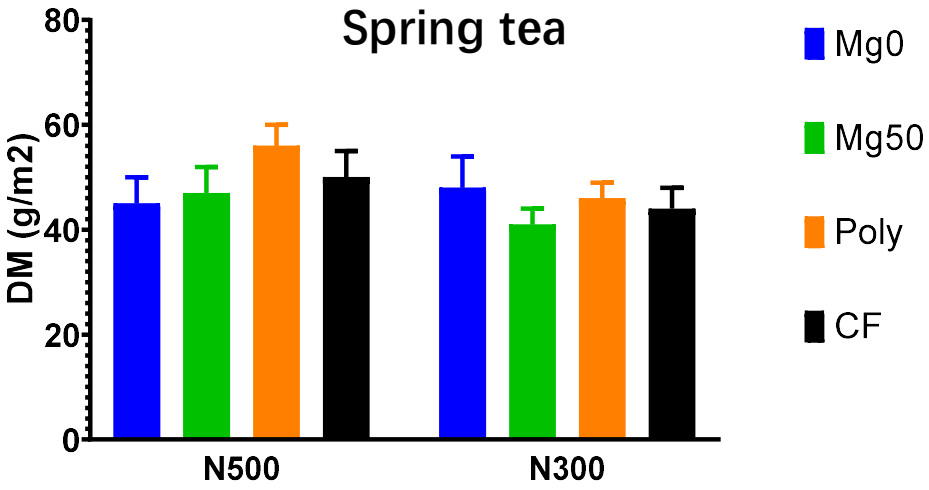
- Soil properties
  - Red clay soil
  - pH 4.8, SOC 0.78%
  - Available N 52 mg/kg, Available P 6 mg/kg
  - Available K 182 mg/kg, Available Mg 36 mg/kg
  - Exch. Ca 126 mg/kg

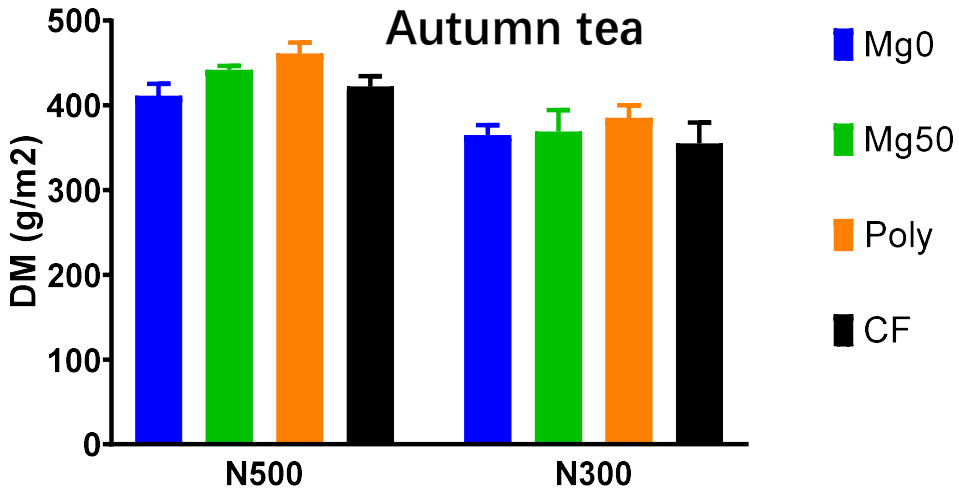


- Strat from spring of 2017 (April)
- Including 2 N levels (N300 and N500), Urea
- 60 kg/ha P_2O_5, SSP
- 90 kg/ha K_2O, SOP
- To keep the same NPK, the Mg addition may be different due to the fertilizer

	N500	N300	Comments
CK	0	0	control
Mg50	50	50	MgSO4·H2O
Poly	38	38	Polyhalite
CF	17	10	N/P/K/Mg Compund

Yield (dry matter)





	DF	MS	P value
Interaction	3	60.50	P=0.5322
N	1	180.5	P=0.1473
Mg	**3**	**67.17**	**P=0.4882**

	DF	MS	P value
Interaction	3	366.0	P=0.7986
N	1	34322	P<0.0001
Mg	**3**	**2211**	**P=0.1354**

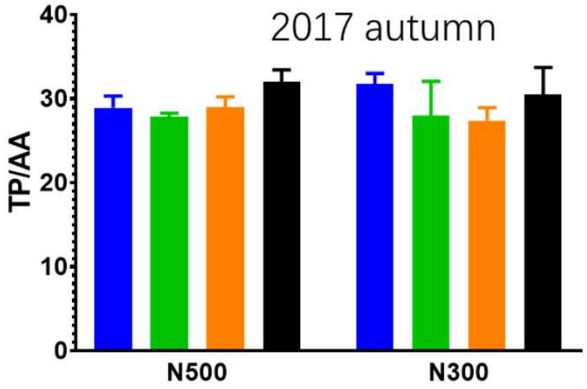
TP/AA (quality index)

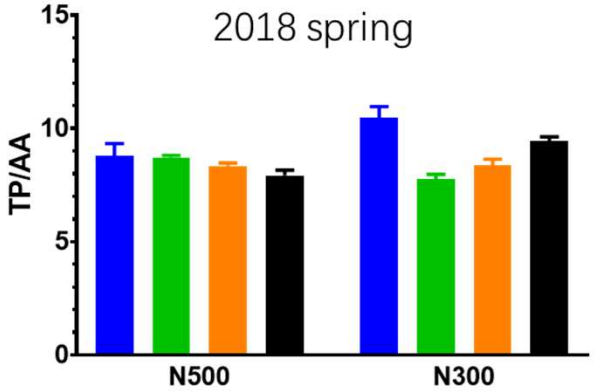
Mg0

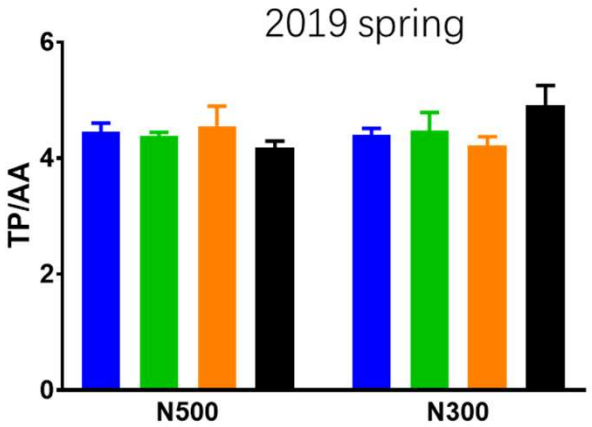
Mg50

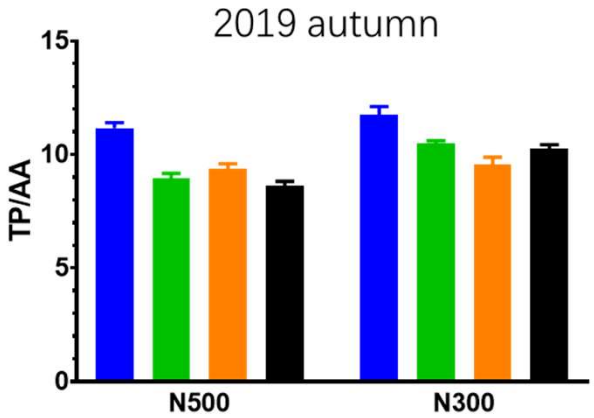
Poly

SCF



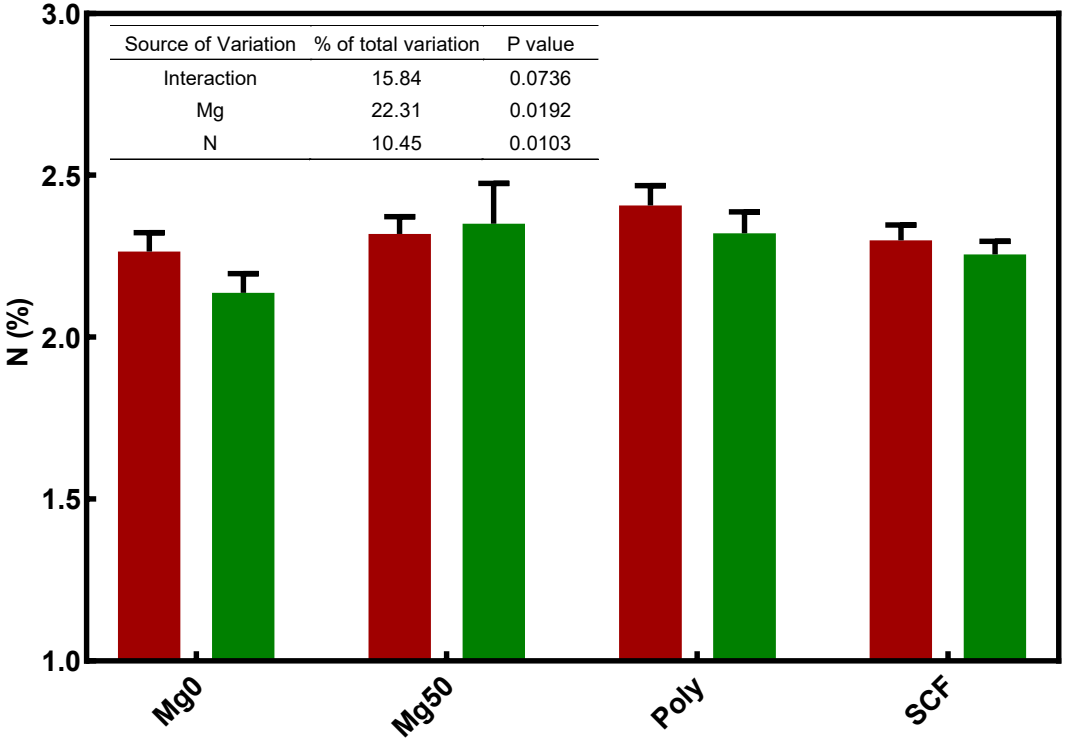




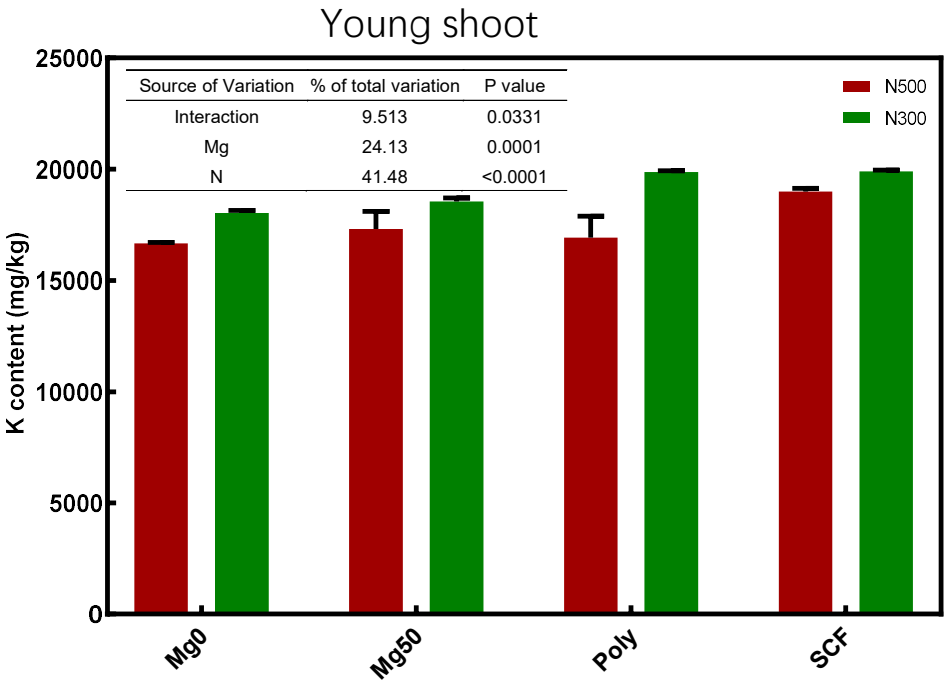


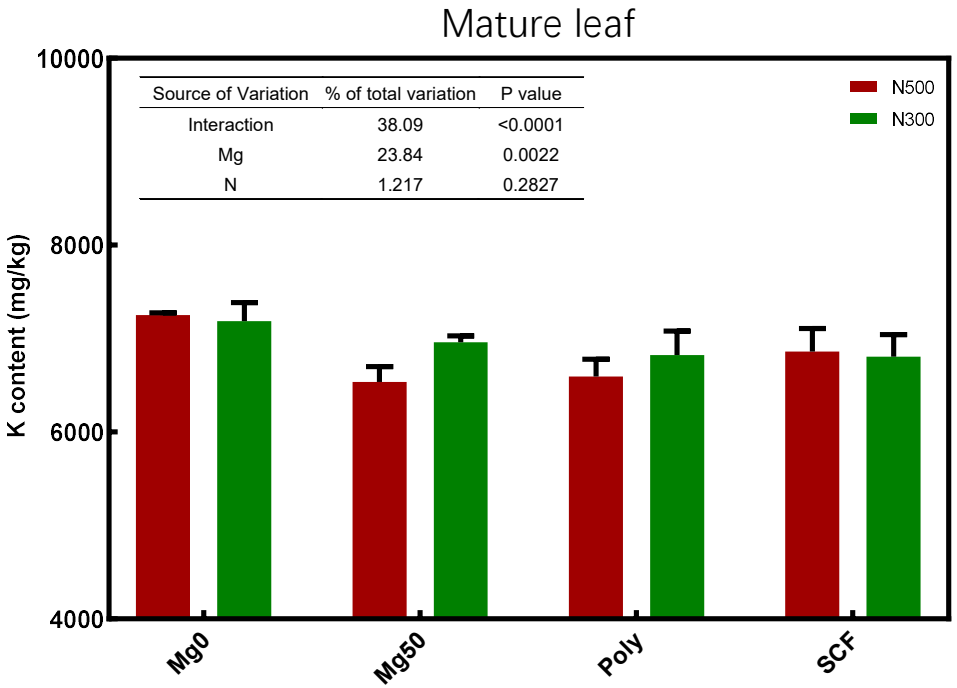
- N rate showed a significant effect (ANOVA, $p<0.001$).
- Mg addition significantly reduced TP/AA, but there was no difference between Mg fertilizers.

- N content in the mature leaves

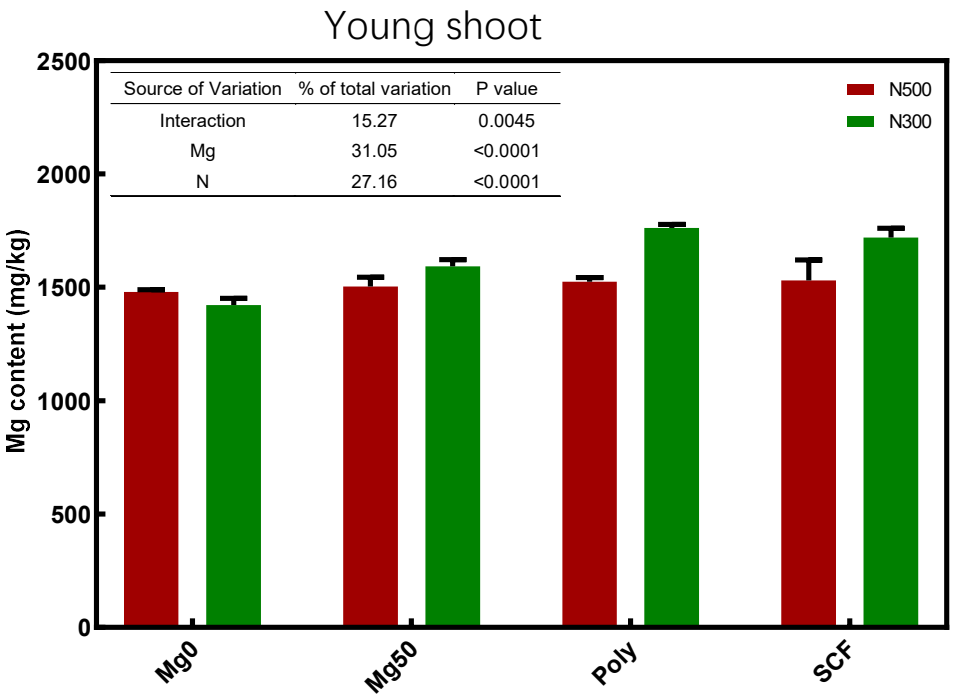


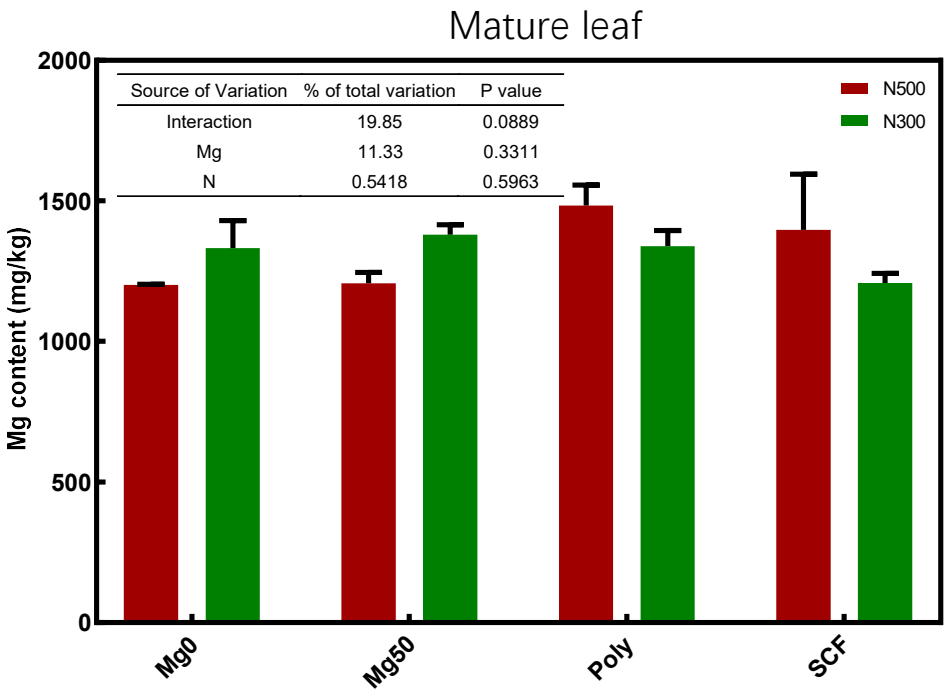
High N increased the N concentration in the tea leaves.
Mg addition showed a significant effect only on N300



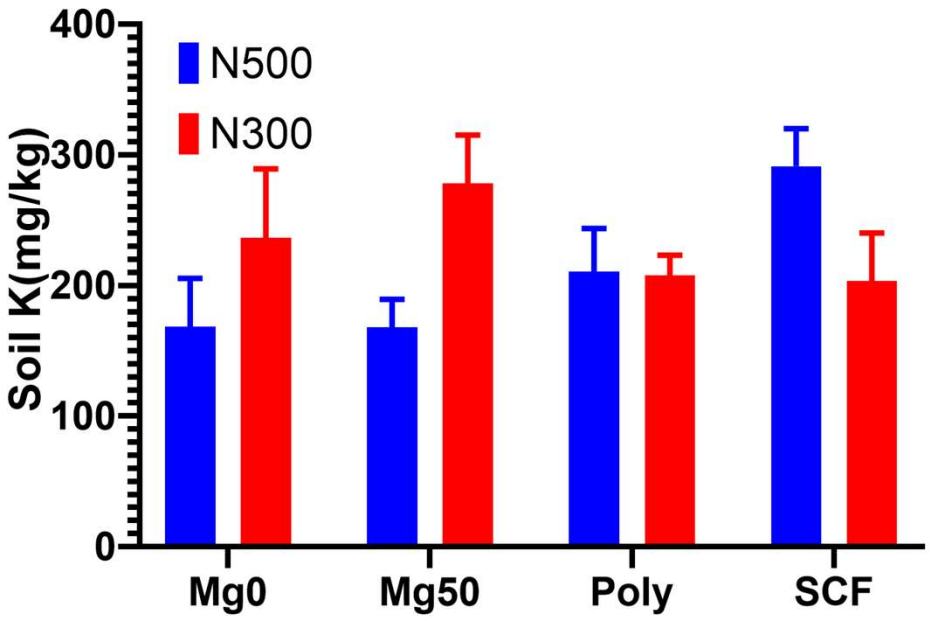


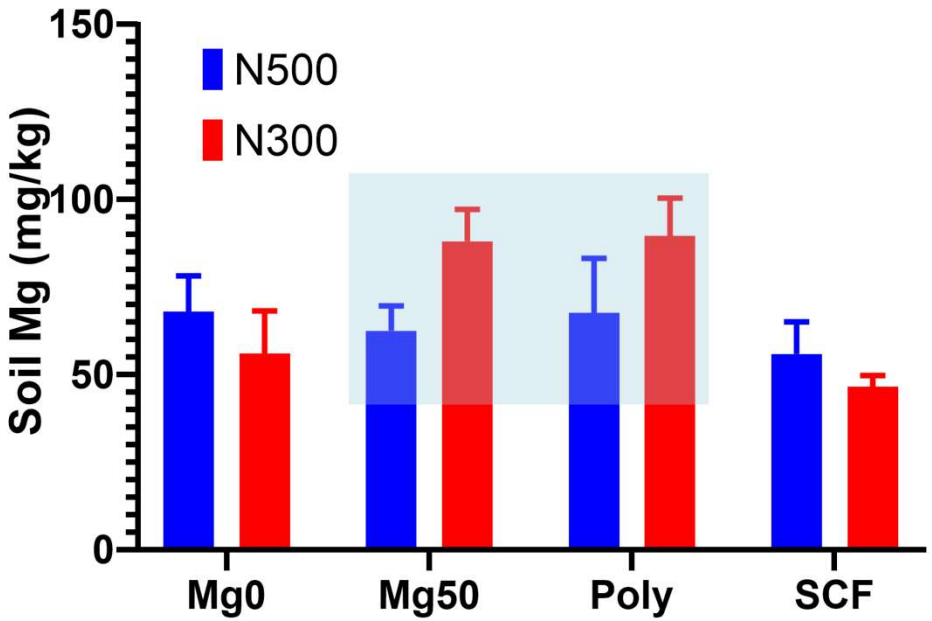
High N reduced the K concentration in young shoots.
Mg addition increase the K accumulation in the young shoots



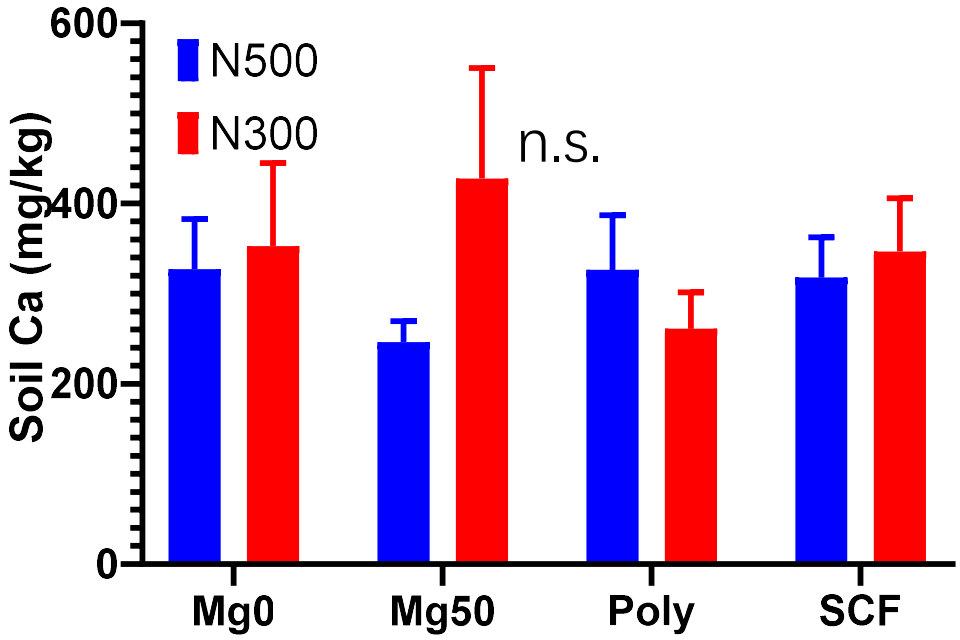


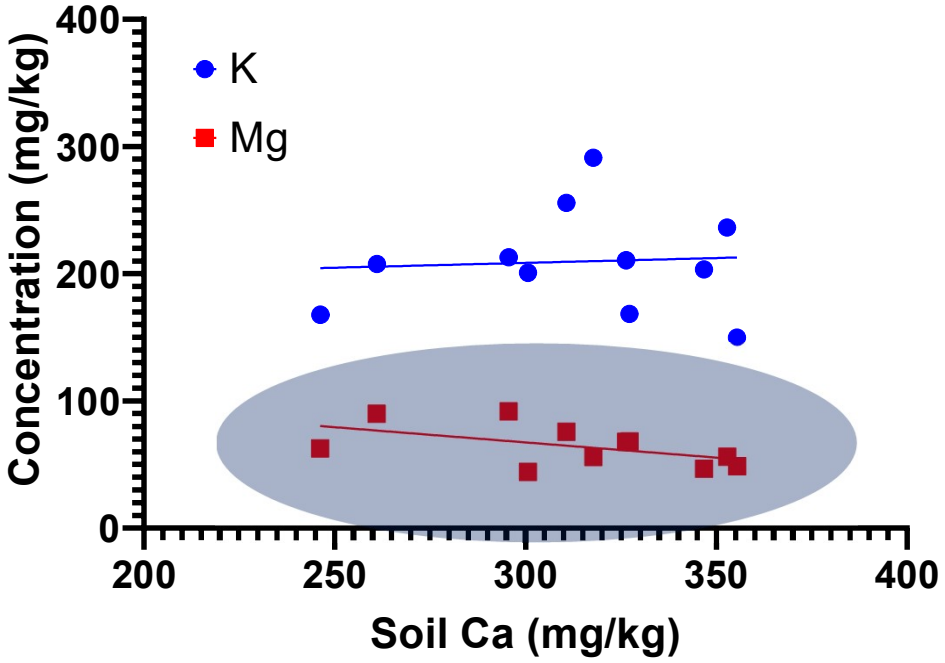
High N (N500) reduced the Mg concentration in young shoots. Polyhalite showed more Mg accumulation in the young shoots, although its Mg rate was less than Mg50





Although lower Mg input than Mg50, but accumulated similar amount of available Mg in surface soil.





No significant Ca accumulation under polyhalite treatment.
Mg addition may increase Ca^{2+} leaching

Summary of the field trial results

- Similar effect on biomass by polyhalite as Mg50 with 25% less Mg input
- Better applied with high N (N500)
- Potential positive effect on improving green tea quality by reducing TP/AA after 3 years application
- No Ca accumulation in the surface soil by 3 years' polyhalite application

Acknowledgement

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SINCE 1952

Mr **Eldad Sokolowski**
Dr **Li Guohua**

ICL Fertilizers
Where needs take us

Poly S K Mg Ca ™
sulphate


Thanks for your listening!