

# Application of Magnesium Fertilizer is Necessary in Chinese Agriculture

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# Outline

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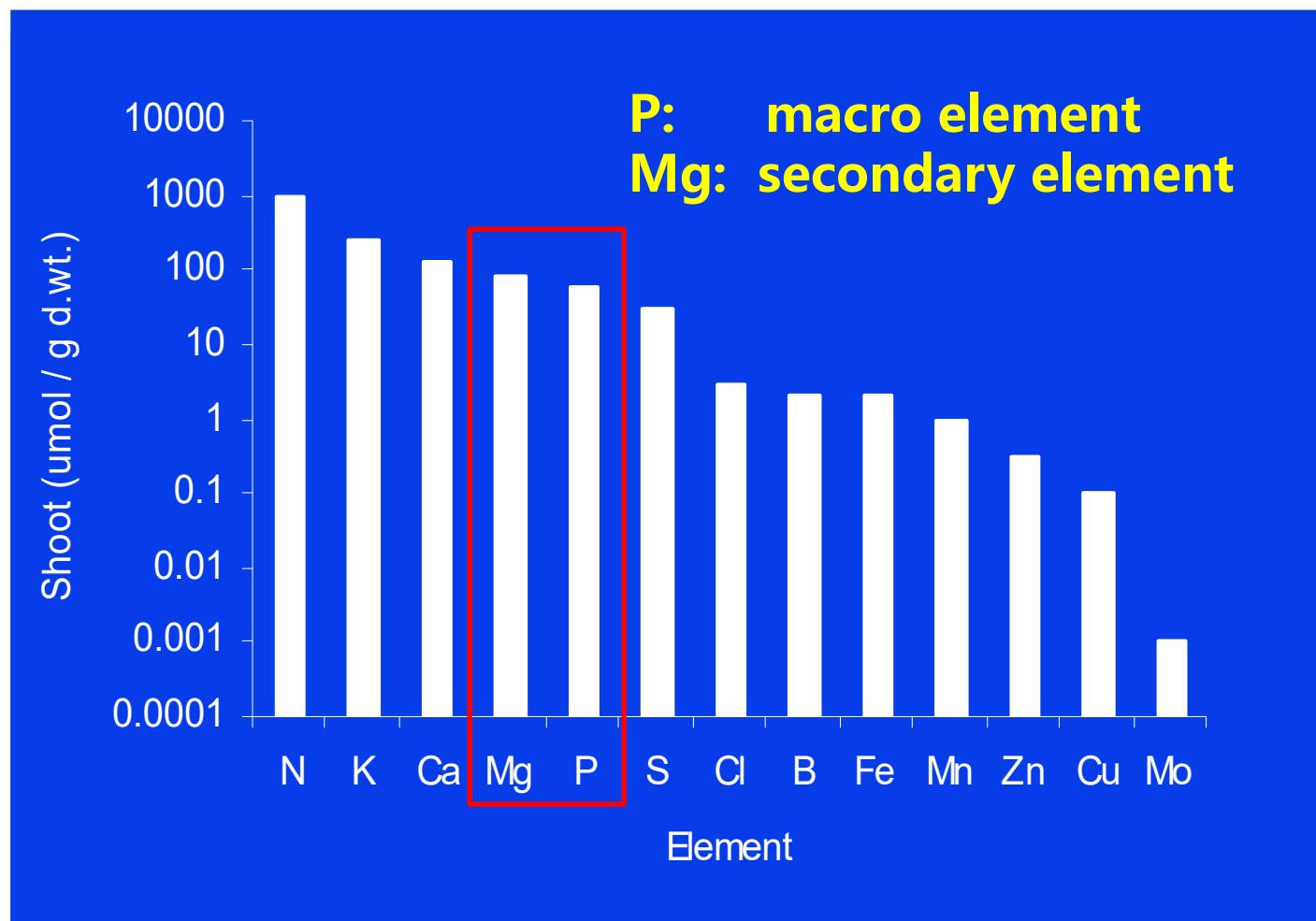


- Magnesium fertilization is neglected in agriculture
- National survey of soil nutrient status and fertilization
- Reducing NPK fertilization and Mg supplemental experiments
- Summary
- Acknowledgments



**Magnesium fertilization is neglected in  
agriculture**

# Average shoot concentrations of essential mineral elements



Marschner 's Mineral Nutrition of Higher Plants, 2012

# Comparison of N, P, K, Mg consumption in the world

(unit: 1000 tons)



| Regions            | N     | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O | MgO |
|--------------------|-------|-------------------------------|------------------|-----|
| Europe             | 14554 | 3683                          | 4119             | 170 |
| South-Eastern Asia | 6500  | 2538                          | 3274             | 118 |
| Northern America   | 14900 | 4416                          | 4765             | 101 |
| Western Africa     | 796   | 240                           | 208              | 8   |

N, P, K consumption data from FAO 2015  
Gaoqiang Huang, K+S Group

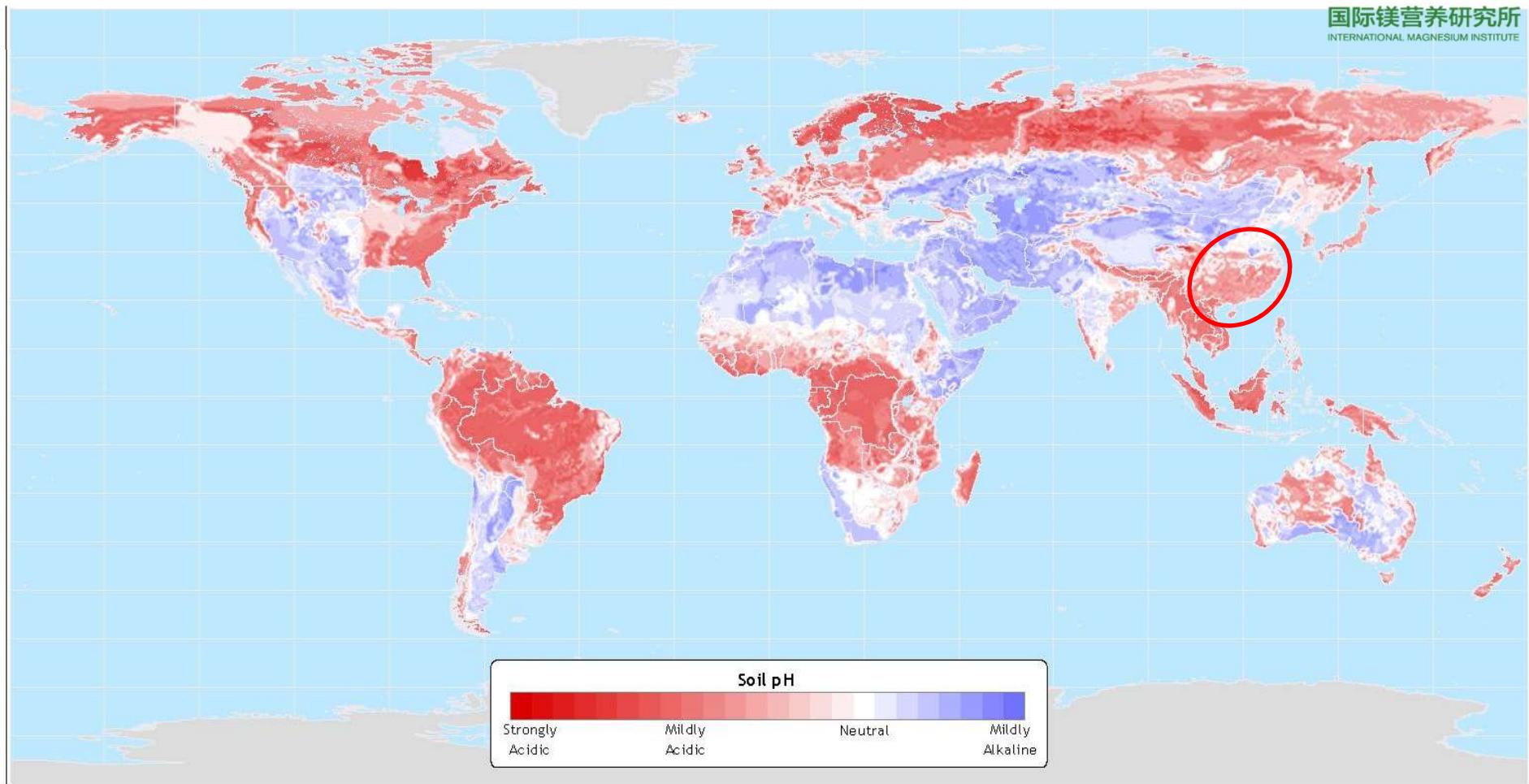
# Magnesium deficiency symptom



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# Soil pH



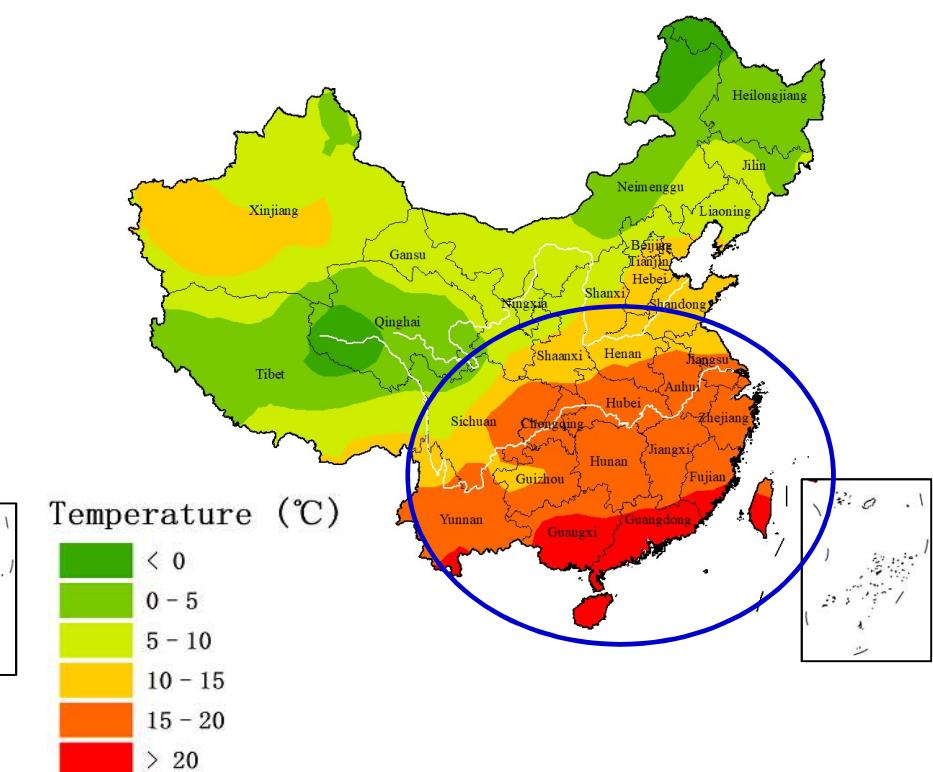
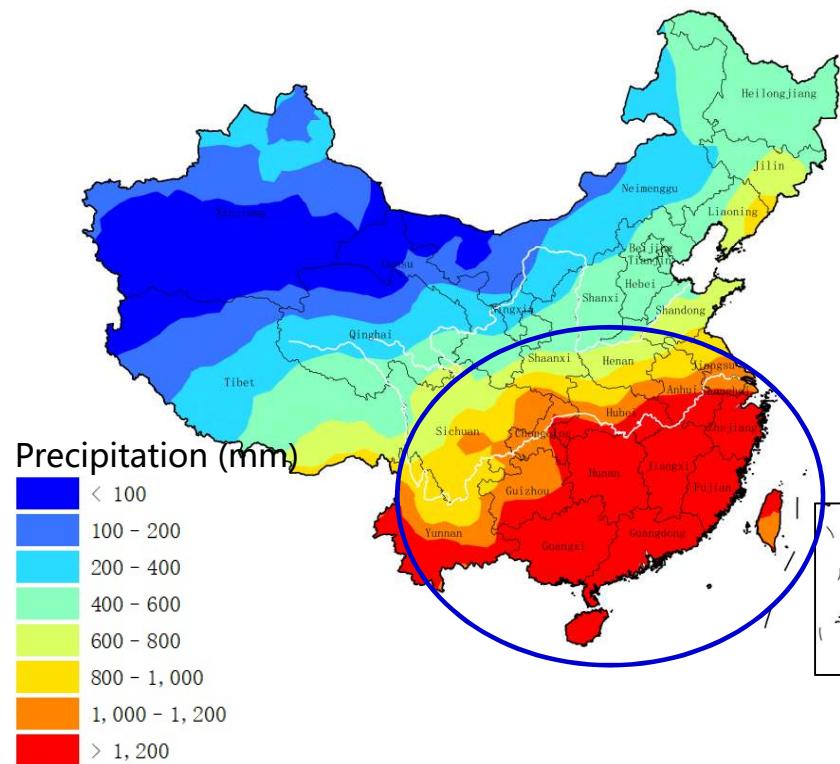
Data taken from: IGBP-DIS Global Soils Dataset (1998)

Atlas of the Biosphere  
Center for Sustainability and the Global Environment  
University of Wisconsin - Madison

# Annual precipitation and temperature in China



Multi-harvest in a year



From Zheng Wang

# INTERNATIONAL MAGNESIUM INSTITUTE



The International Magnesium Institute (IMI) was founded in September 2016

## 1 RESEARCH

*Soil-plant system  
New fertilizers*

## 2 EDUCATION

*Young scientists  
Graduate students  
Farmers, agro-technicians  
and commercial staff*



## 3 DEVELOPMENT

*Demonstration and extension  
Alliance with fertilizer industries  
International network*

## 4 KNOWLEDGE TRANSFER

*Knowledge bank and information  
dissemination  
Meta data platforms  
Publications*

# 3<sup>rd</sup> International Symposium on Magnesium



3<sup>rd</sup> International Symposium on Magnesium

(25-28 November 2018, Guangzhou, China)





# **National survey of soil nutrient status and fertilization**

A National Magnesium Network (NMN) has been set up

# Farmers' survey results of 0-20 cm soil nutrients status, crop yield and fertilizer inputs for different crops in different provinces of China



| Province     | Crop         | Yield                  | Soil | Soil nutrient concentration ( $\text{mg kg}^{-1}$ ) |         |         |         | Farmers' | fertilization ( $\text{kg ha}^{-1}$ ) |                        |                      |              |
|--------------|--------------|------------------------|------|---|---------|---------|---------|----------|---------------------------------------|------------------------|----------------------|--------------|
|              |              | ( $\text{t ha}^{-1}$ ) | pH   | AN  | AP      | AK      | Ex.Mg   |          | N                                     | $\text{P}_2\text{O}_5$ | $\text{K}_2\text{O}$ | $\text{MgO}$ |
| Fujian       | Pomelo       | 56.3±20.9              | 4.4  | 101±35  | 175±15  | 179±38  | 57±43   | 1175±535 | 909±313                               | 971±298                | 68±30 (62%)          |              |
| Fujian       | Tea          | 1.6±0.4                | 4.2  | 120±25  | 54±26   | 85±29   | 26±13   | 484±591  | 238±333                               | 265±304                | 0                    |              |
| Fujian       | Sweet pepper | 59.8±23.6              | 6.1  | 114±34  | 109±31  | 246±3   | 107±41  | 768±201  | 335±96                                | 911±322                | 0                    |              |
| Guangdong    | Sugarcane    | 85.5±15.6              | 4.6  | 127±20  | 171±24  | 156±46  | 34±38   | 450±85   | 300±64                                | 320±77                 | 0                    |              |
| Guangdong    | Wax gourd    | 89.9±53.2              | 6.2  | 111±10  | 207±13  | 193±48  | 270±58  | 391±144  | 336±91                                | 372±105                | 10±5 (5%)            |              |
| Hainan       | Pineapple    | 56.1±36.4              | 4.0  | 62±27   | 198±106 | 71±46   | 37±61   | 1103±544 | 707±293                               | 979±411                | 23± 18 (43%)         |              |
| Hainan       | Pepper       | 27.0±11.3              | 5.5  | 106±22  | 121±77  | 101±79  | 80±40   | 511±149  | 463±143                               | 511±179                | 0                    |              |
| Guizhou      | Pepper       | 22.4±11.5              | 5.1  | 125±31  | 125±59  | 159±77  | 101±70  | 379±139  | 325±188                               | 230±97                 | 0                    |              |
| Sichuan      | Orange       | 27.8±11.2              | 4.6  | 122±46  | 233±27  | 348±178 | 158±126 | 654±336  | 372±276                               | 554±299                | 0                    |              |
| Hubei        | Rapeseed     | 2.4±0.8                | 6.4  | 111±41  | 19±2    | 156±117 | 316±134 | 390±109  | 542±198                               | 242±89                 | 0                    |              |
| Jiangsu      | Cucumber     | 30.8±5.3               | 6.8  | 91±17   | 18±8    | 153±78  | 582±202 | 466±121  | 210±74                                | 220±57                 | 0                    |              |
| Jiangsu      | Rice         | 9.1±1.8                | 7.1  | 171±59  | 36±15   | 164±81  | 518±234 | 300±98   | 95±32                                 | 95±23                  | 0                    |              |
| Jiangxi      | Navel orange | 31.2±14.1              | 4.6  | 125±50  | 75±38   | 285±133 | 77±59   | 316±115  | 200±114                               | 324±99                 | 0                    |              |
| Zhejiang     | Tea          | 0.9±0.5                | 4.0  | -   | 59±24   | 164±148 | 68±80   | 521±638  | 361±353                               | 209±231                | 0                    |              |
| Xinjiang     | Grape        | 22.0±3.7               | 8.0  | 75±27   | 43±20   | 258±93  | 322±84  | 312±126  | 254±67                                | 287±116                | 0                    |              |
| Heilongjiang | Rice         | 6.1±2.2                | 6.1  | 166±45  | 25±9    | 159±63  | 283±95  | 156±67   | 66±34                                 | 93±40                  | 0                    |              |
| Shandong     | Tomato       | 115.5±32               | 7.9  | 157±38  | 242±71  | 309±78  | 276±144 | 1158±383 | 1181±455                              | 1202±454               | 12±3 (42%)           |              |

# Fertilizer input and budget for pomelo production in Pinghe county, Fujian Province

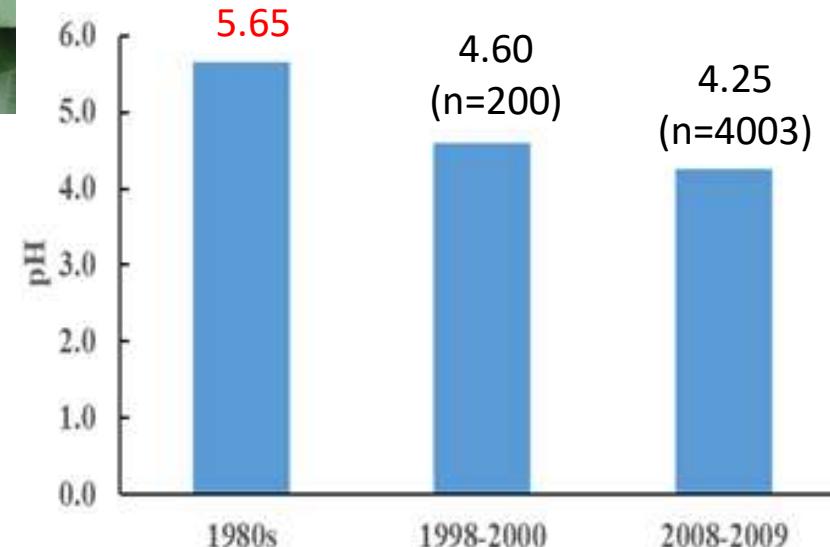


| Fertilizer                          | Input    | Removal  | Budget   |
|-------------------------------------|----------|----------|----------|
| N kg/ha                             | 1206±508 | 80±40    | 1126±511 |
| P <sub>2</sub> O <sub>5</sub> kg/ha | 971±431  | 17.5±9.4 | 954±431  |
| K <sub>2</sub> O kg/ha              | 955±368  | 81±43    | 874±367  |

(Yield 55t/ha, n=362)

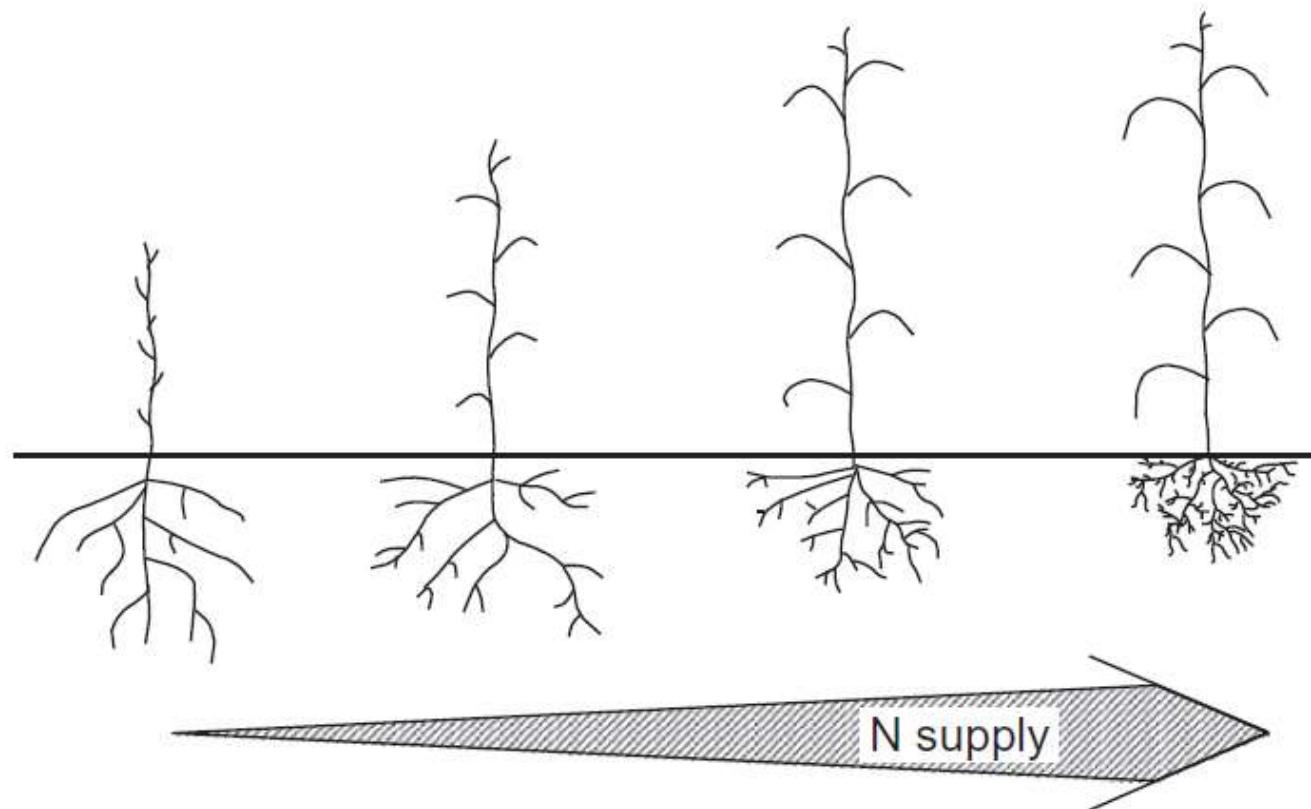
(Qin *et al.*, 2016; Wu et al., unpublished)

Changes in soil pH



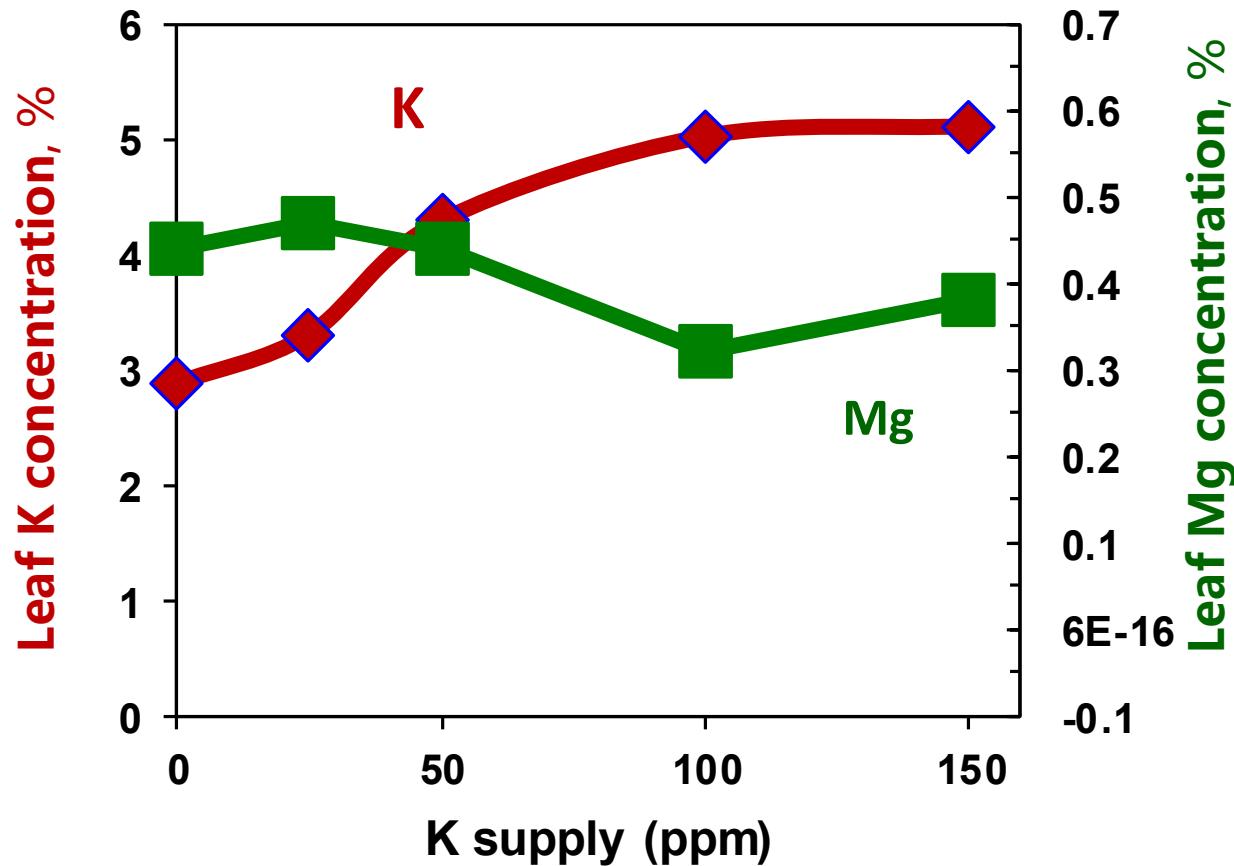
Wu et al., unpublished

# Nitrogen application and root architecture



Marschner 's Mineral Nutrition of Higher Plants, 2012

# Influence of increasing K supply on leaf K and Mg concentrations of cowpea plants (pot experiment)



Plant Soil, Narwal et al., 1985

# Influence of K<sup>+</sup> and Ca<sup>2+</sup> on Mg<sup>2+</sup> uptake by barley seedlings<sup>a</sup>



| Tissue | Mg <sup>2+</sup> uptake ( $\mu\text{eq Mg}^{2+}(10\text{g})^{-1}$ fresh weight (8h) $^{-1}$ ) |                                      |   |
|--------|---|--------------------------------------|---|
|        | MgCl <sub>2</sub>   | MgCl <sub>2</sub> +CaSO <sub>4</sub> | MgCl <sub>2</sub> +CaSO <sub>4</sub> +KCl |
| Roots  | 165   | 115                                  | 15  |
| Shoot  | 88  | 25                                   | 6.5                                       |

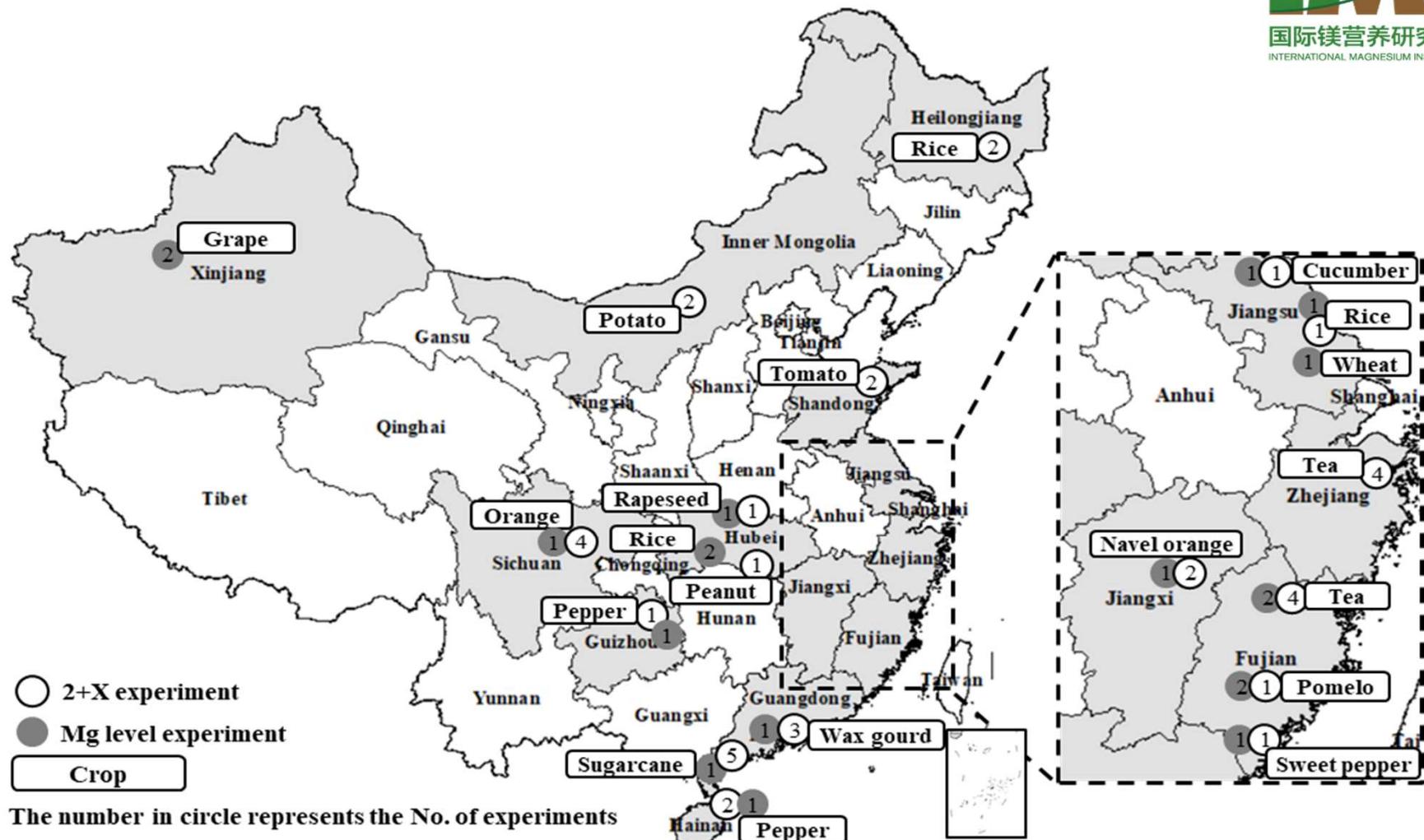
<sup>a</sup> Concentration of all cations 0.25meq l<sup>-1</sup>

According to Schimansky (1981) results

## **Reducing NPK fertilization and Mg supplemental experiments**

All of the experiments with Mg fertilizer addition was performed at the basis of reducing NPK fertilization

# Location of reducing NPK and Mg addition experiments and the related crops in different provinces of China



From Zheng Wang, unpublished

# Effects of reducing NPK fertilizer input and addition of magnesium fertilizer on crop yield



| Experimental site          | Crop         | Reduced fertilizer in OPT treatment<br>(kg ha <sup>-1</sup> ) |                               |                  | MgO<br>input<br>(kg ha <sup>-1</sup> ) | Yield (t ha <sup>-1</sup> ) |         |         | Yield increase(%) |                   |
|----------------------------|--------------|---|-------------------------------|------------------|--|-----------------------------|---------|---------|-------------------|-------------------|
|                            |              | N   | P <sub>2</sub> O <sub>5</sub> | K <sub>2</sub> O |  | FP                          | OPT     | OPT+Mg  | OPT vs. FP        | OPT+Mg<br>vs. OPT |
| Pinghe, Fujian             | Pomelo       | 283 (24%)   | 122 (22%)                     | 103 (11%)        | 255                                    | 54.8 b                      | 57.2 ab | 60.2 a  | 4.5               | 5.2               |
| Anxi, Fujian               | Tea          | 230 (46%)   | 138 (58%)                     | 153 (6%)         | 35                                     | 7.5 b                       | 7.6 ab  | 7.8 a   | 0.9               | 3.2               |
| Zhaohan, Fujian            | Sweet pepper | 162 (41%)   | 281 (74%)                     | 92 (16%)         | 100                                    | 48.0 b                      | 50.6 ab | 53.0 a  | 5.4               | 4.7               |
| Zhanjiang, Guangdong       | Sugarcane    | 98 (18%)  | 143 (42%)                     | 17 (5%)          | 42                                     | 82.6 b                      | 86.9 ab | 96.1 a  | 5.5               | 11.7              |
| Guangzhou, Guangdong       | Wax gourd    | 40 (8%)   | 135 (38%)                     | 45 (11%)         | 100                                    | 83.3 c                      | 88.4 b  | 99.6 a  | 6.5               | 12.2              |
| Lingao, Hainan             | Pepper       | 22 (3%)   | 400 (61%)                     | 41 (6%)          | 48                                     | 29.9 b                      | 35.0 a  | 35.4 a  | 17.5              | 1.3               |
| Jinping, Guizhou           | Pepper       | 113 (31%)   | 113 (31%)                     | 113 (31%)        | 75                                     | 11.6 b                      | 11.8 b  | 13.4 a  | 1.7               | 10.2              |
| Danling, Sichuan           | Orange       | No FP   | No FP                         | No FP            | 124                                    | No FP                       | 42.4 a  | 43.3 a  | No FP             | 0.8               |
| Wuxue, Hubei               | Rapeseed     | 60 (25%)  | 15 (17%)                      | -15 (-17%)       | 15                                     | 1.7 b                       | 1.7 b   | 2.0 a   | 0.6               | 18.2              |
| Wuxue, Hubei               | Peanut       | 60 (25%)  | 15 (17%)                      | -15 (-17%)       | 15                                     | 2.9 b                       | 3.6 a   | 3.9 a   | 24.1              | 3.9               |
| Liyang, Jiangsu            | Cucumber     | 250 (42%)   | 0                             | 0                | 120                                    | 24.4 b                      | 29.1 a  | 29.3 a  | 19.3              | 0.7               |
| Rugao, Jiangsu             | Rice         | 60 (20%)  | 0                             | 0                | 40                                     | 10.1 a                      | 10.3 a  | 10.3 a  | 1.3               | 0.7               |
| Ganzhou, Jiangxi           | Navel orange | No FP   | No FP                         | No FP            | 94                                     | No FP                       | 24.3 a  | 27.3 a  | No FP             | 9.0               |
| Shengzhou, Zhejiang        | Tea          | No FP   | No FP                         | No FP            | 35                                     | No FP                       | 1.3 a   | 1.3 a   | No FP             | 1.9               |
| Wuchang, Heilongjiang      | Rice         | 15 (14%)  | 0                             | 0                | 15                                     | 7.0 b                       | 8.0 a   | 8.2 a   | 13                | 3.7               |
| Shouguang, Shandong        | Tomato       | No FP   | No FP                         | No FP            | 102                                    | No FP                       | 97.2 b  | 109.3 a | No FP             | 13.0              |
| Wulanchabu, Inner Mongolia | Potato       | No FP   | No FP                         | No FP            | 90                                     | No FP                       | 37.0 b  | 42.7 a  | No FP             | 15.5              |

From Zheng Wang, unpublished

# Farmers fertilization (Pomelo in Pinghe)



N ( kg/ha ) 1084

P<sub>2</sub>O<sub>5</sub> ( kg/ha ) 914

K<sub>2</sub>O ( kg/ha ) 906

# Reducing 90% of the fertilization input



N ( kg/ha ) 200

P<sub>2</sub>O<sub>5</sub> ( kg/ha ) 0

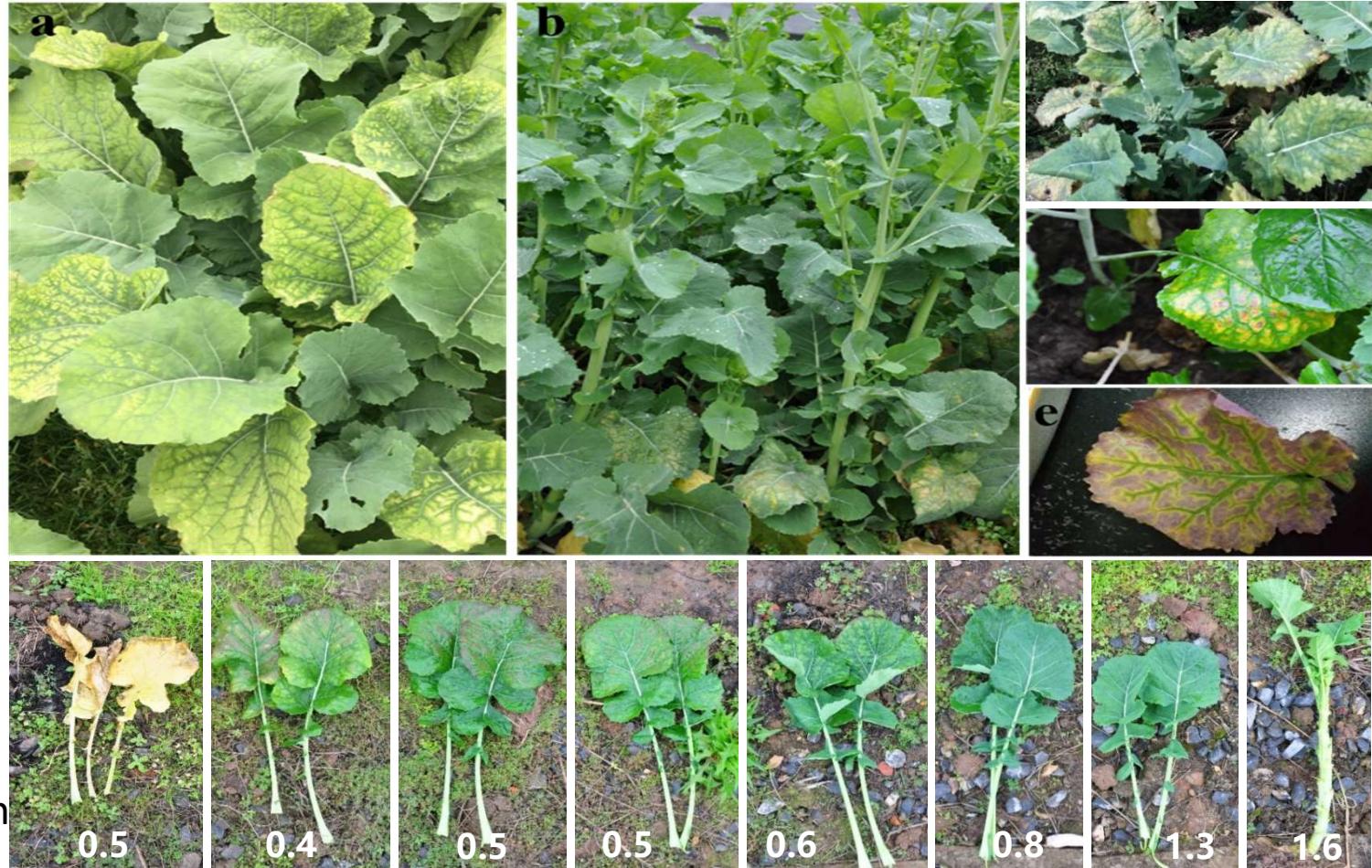
K<sub>2</sub>O ( kg/ha ) 200

# Over view of the experimental plots



# Rapeseed experiment in Hubei province

Soil pH 4.7, exchangeable Mg 36.4 mg/kg



Leaf Mg  
concentration

From Zhifeng Lu

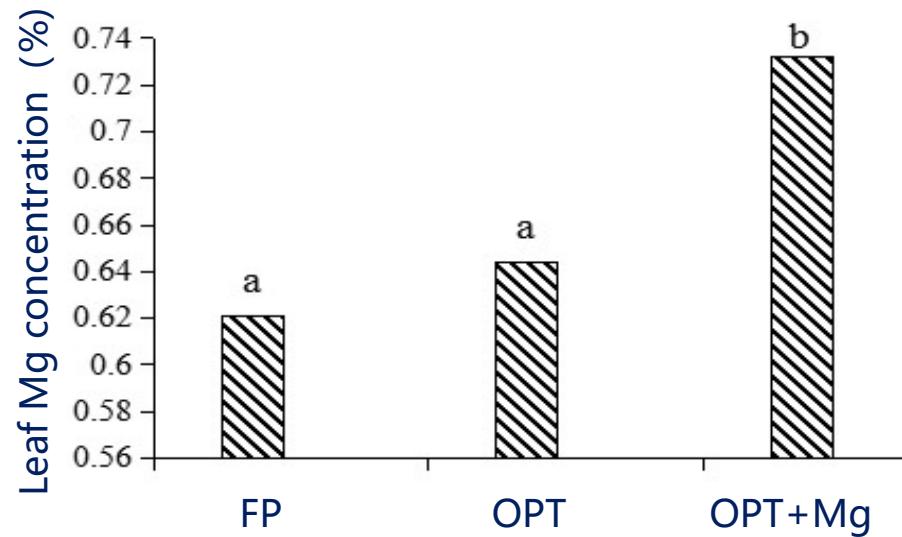
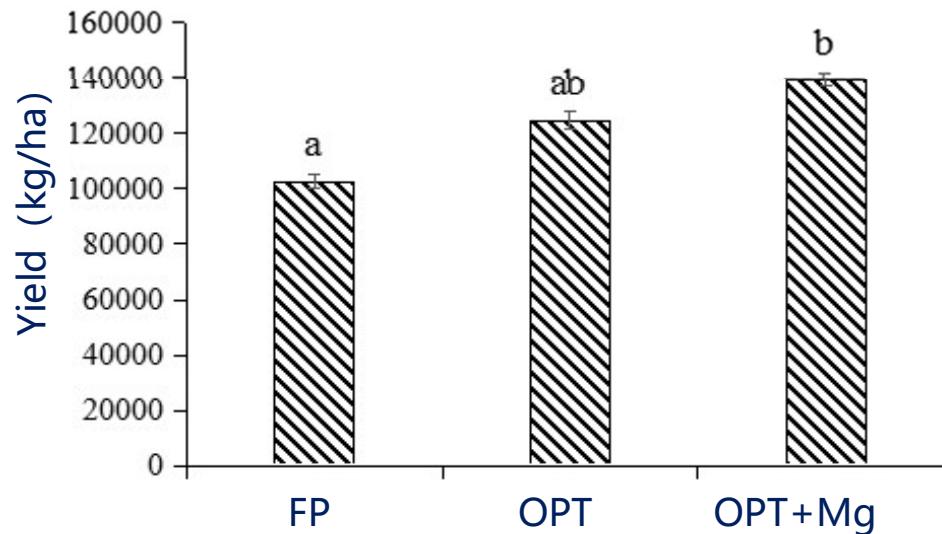
# Influences of reducing NPK input and addition of Mg fertilizer on yield and quality of rapeseed



| Treatment | Yield<br>(kg hm <sup>-2</sup> ) | Silique number<br>(plant) | Oil content<br>(%) |
|-----------|---------------------------------|---------------------------|--------------------|
| FP        | 1815                            | 300                       | 42.2               |
| OPT       | 2070                            | 309                       | 42.6               |
| OPT+Mg    | 2175                            | 322                       | 43.0               |

From Jianwei Lu

# Tomato greenhouse experiment in Shandong province

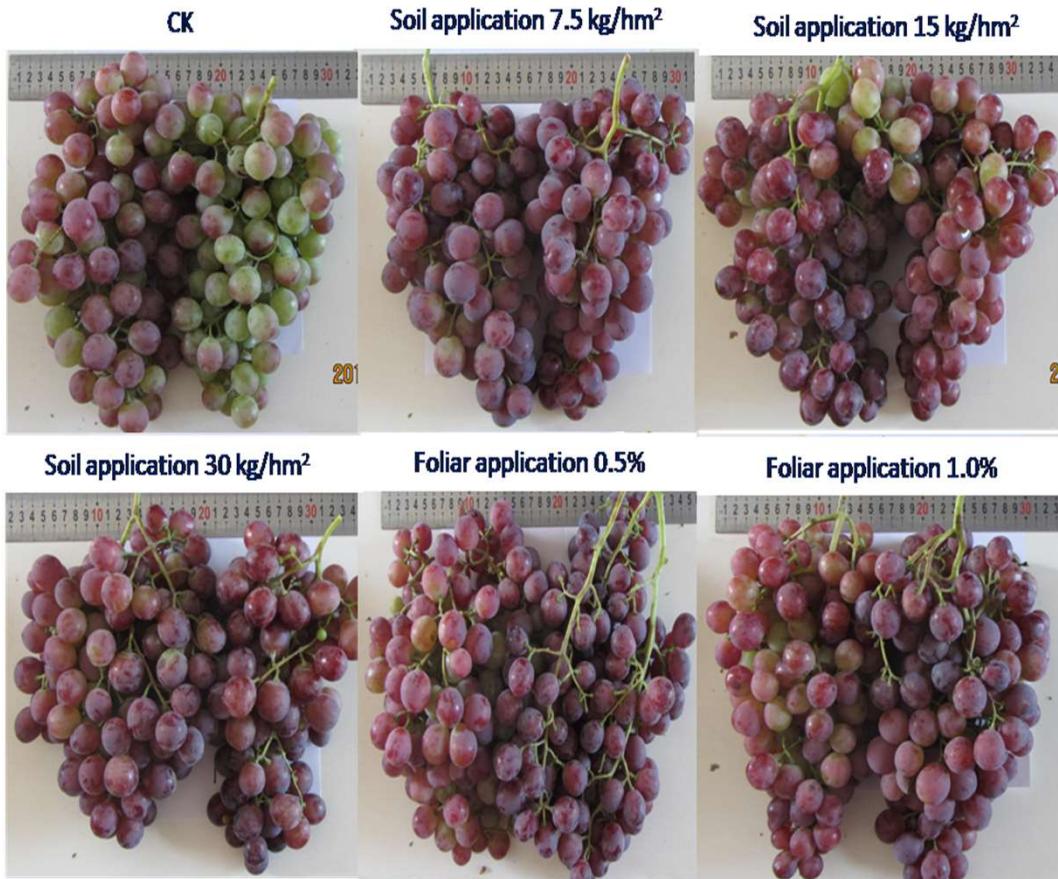


From Xiaodong Ding

# Tomato greenhouse experiment in Shandong province



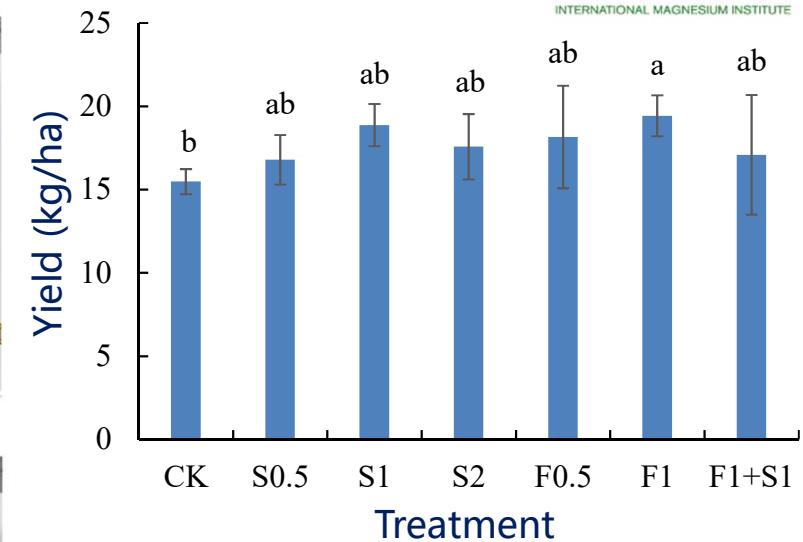
# Effect of Mg application on yield and quality of grape in Xinjiang calcareous soil



Xinjiang

Soil pH 8.1, exchangeable Mg 343 mg/kg

Exchangeable Ca 7459 mg/kg



From Juan Wang

# Summary

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- Magnesium is a macro, not secondary element
- Balanced fertilization is important for better growth and development of plants
- Reducing NPK fertilization increases crop yield, supplement of Mg fertilizer further increases crop yield

# Acknowledgments

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- National Magnesium Network (NMN)
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