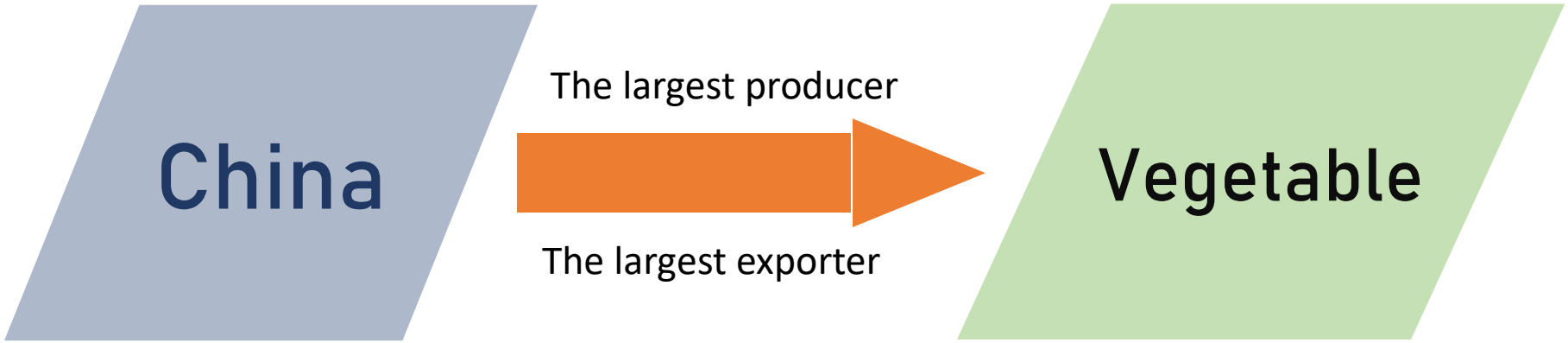
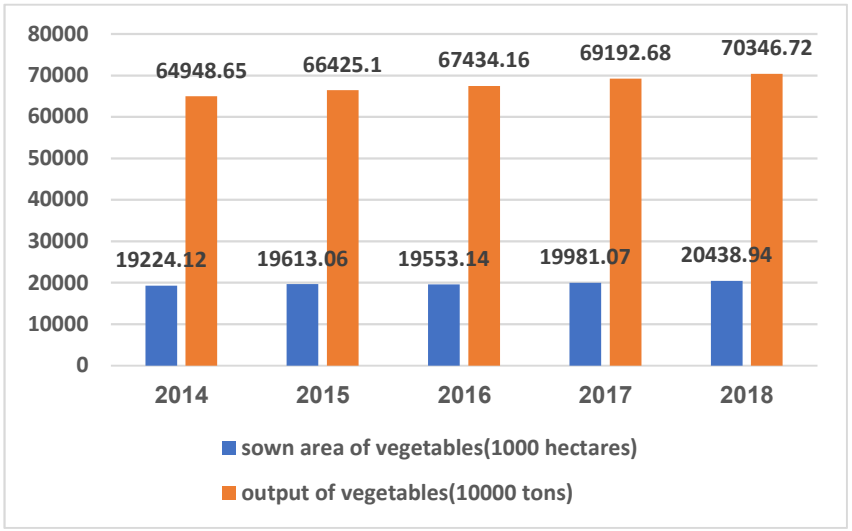
Effect on potassium on leafy vegetables and efficient potassium application technology

Wanyi Zhao/Zhengyin Wang

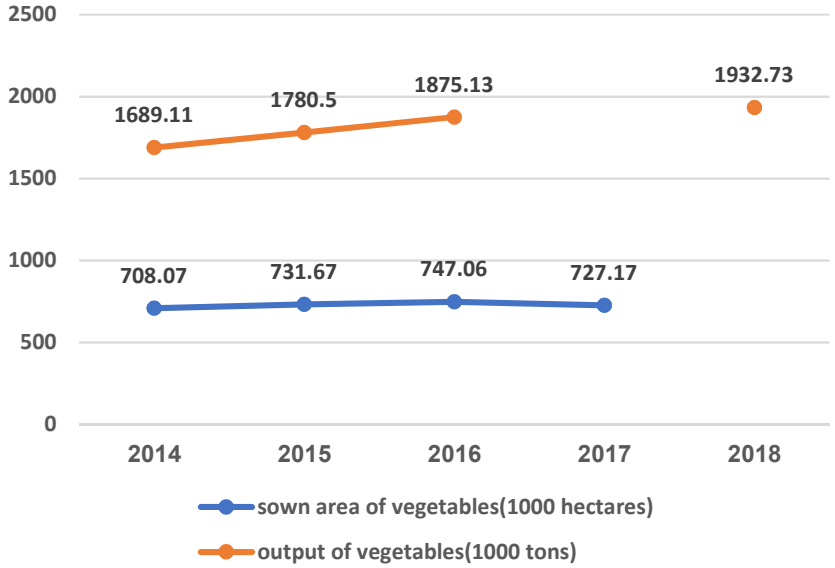
Southwest University


China
The largest producer
The largest exporter
Vegetable

Over the past five years, the planting area and yield of vegetables have been on the rise in China



The sown area and output of vegetables in China for latest 5 years



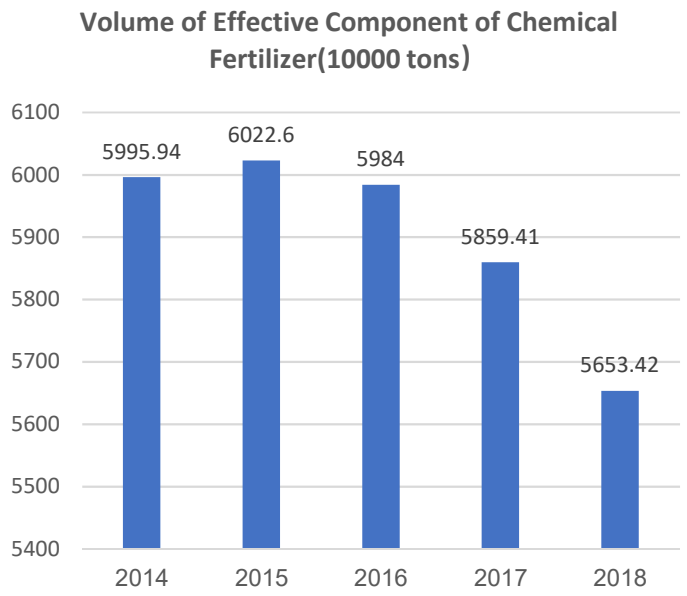
The sown area and output of vegetables in Chongqing for latest 5 years

National Bureau of Statistics , 2014-2018

Problems
of chemical fertilizer application

1. Excessive fertilizer input and nutrient imbalance.
2. Unreasonable model of organic manure application combined with chemical fertilizers.
3. Improper medium trace element fertilization.
4. Special fertilizer types and the quantity are not balanced.
5. The quality of organic manure is uneven.
6. Improper fertilizer application method.

The amount of chemical fertilizer has continued to decline over the past five years, which is still much higher than the standard.



National Bureau of Statistics , 2014-2018

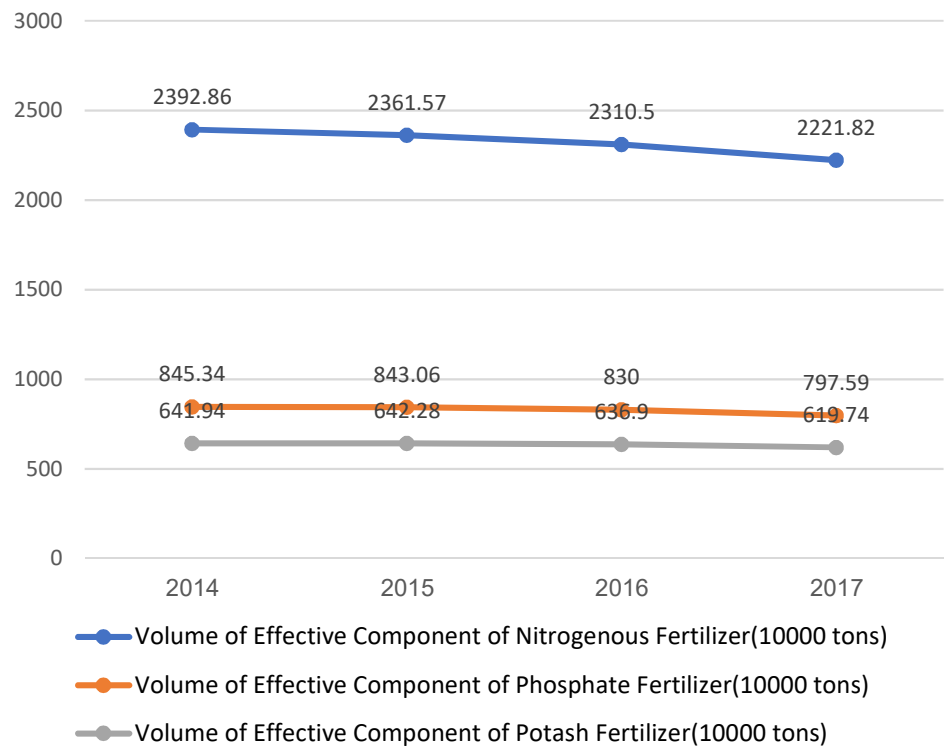
To explore accurate and scientific fertilization technical system

Five technical focal points (5R)

Right Rate	Right Pattern	Right Source	Right Time	Right Place

Huang, Chinese Academy of Agricultural Sciences

Volume of Effective Component of Nitrogenous, Phosphate and Potash Fertilizer(10000 tons)



National Bureau of Statistics , 2014-2018

Element	Extremely low	Low	Middle	High
N	< 100	100~200	200~300	> 300
P	< 30	30~60	60~90	> 90
K	< 80	80~160	160~240	> 240
Ca	< 400	400~800	800~1200	> 1200
Mg	< 60	60~120	120~180	> 180
S	< 400	40~80	80~120	> 120

Lu and Chen, 2009

The detection result of greenhouse vegetable soil samples from 2009-2014 in Shou guang

2009			2012			2014		
Crops	age of greenhouse/a	Available K/mg ·kg^{-1}	Crops	age of greenhouse/a	Available K/mg ·kg^{-1}	Crops	age of greenhouse/a	Available K/mg ·kg^{-1}
Balsam pear	5	235	Tomato	5	559	Cucumber	6	2144
Cucumber	3	149	Tomato	3	478	Cucumber	9	594
Eggplant	4	134	Cucumber	9	705	Towel ground	3	556
Eggplant	7	181	Eggplant	7	482	Cucumber	5	1918
Cucumber	6	167	Tomato	6	574	Cucumber	4	1748
Melon	5	240	Cucumber	5	534	Tomato	5	809
Peper	4	290	Cucumber	6	433	Tomato	3	1433
Cucumber	5	364	Pepper	3	479	Pepper	5	863
Towel ground	3	148	Pepper	3	682	Eggplant	8	679
Tomato	3	134	Melon	5	702	Tomato	6	1080
			Melon	5	534	Towel ground	3	2090
			Eggplant	7	490			

*Data summarized from soil fertilizer testing room, Weifang college of science and technology

technical index of recommended potassium fertilization for the main vegetable crops

Soil nutrient level	Relative yield (%)	Available K (mg kg^{-1})			Recommended dosage of K_2O (kg hm^{-2})		
		Leafy vegetables	Gourd vegetables	Leguminous vegetables	Leafy vegetables	Gourd vegetables	Leguminous vegetables
Extremely low	50–70	1–8.5	7–35	8–30	165–235	220–305	185–260
Low	70–80	8.5–27	35–70	30–65	130–165	185–220	145–185
Middle	80–90	27–85	70–160	65–135	95–130	140–185	105–145
High	90–95	85–150	160–235	135–195	75–95	120–140	80–105
Extremely high	>95	>150	>235	>195	<75	<120	<80

Wang, 2017

The volume of chemical fertilizer for vegetables in some parts of China （kg/ha）

Region	samples	N	P_2O_5	K_2O	Total
China	2810	300	210	180	690
Chongqing	268	375	300	270	945
Anhui	89	360	360	195	915
Gansu	114	435	450	90	975
Sichuan	139	180	60	45	285
Hebei	50	180	90	90	360
Shandong	1147	300	225	225	750
Guangdong	66	330	270	435	1035

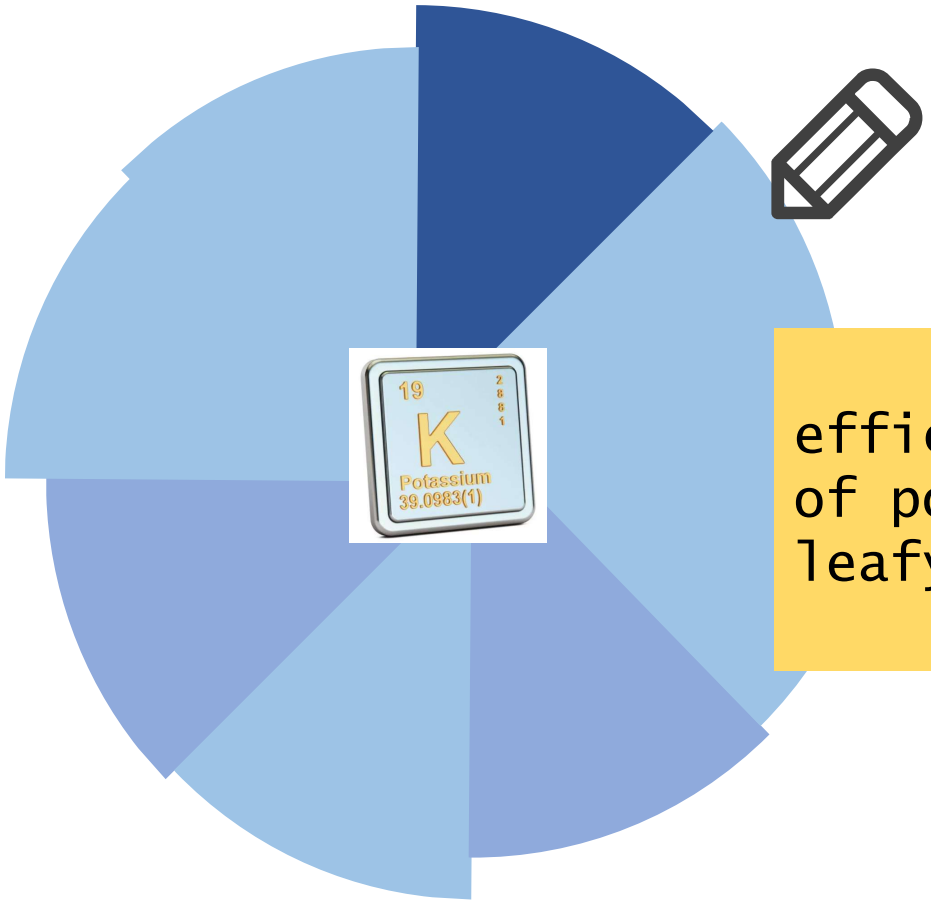
* China Agricultural University: Research report on fertilizer development in China, 2013

Improper application of potassium fertilizer

a

b

Picture a and b show that excessive potassium fertilizer application causes blossom-end rot and yellow leaves in vegetables.

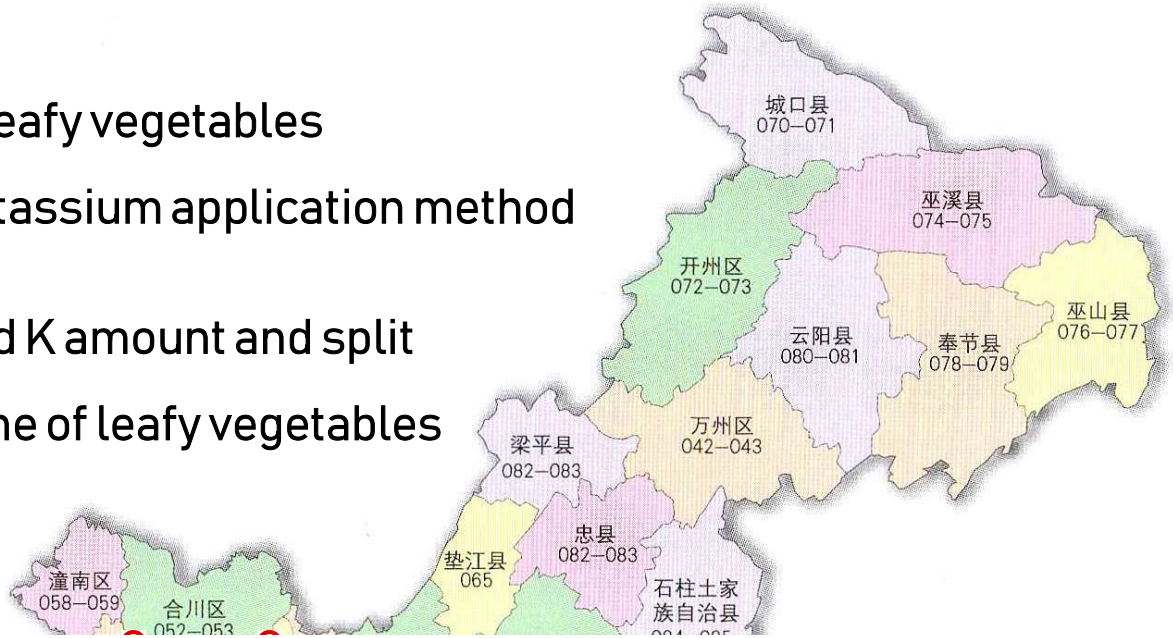


efficient technology
of potash application in
leafy vegetables

Field experiment

- 2008-2012, Study on leafy vegetables response to different potassium application method

- 2012, Effect of reduced K amount and split application in root zone of leafy vegetables



- 2013, Studies of chemical K replacement experiment on leafy vegetables and demenstration

- 2014, Effect of slow release compound fertilizer on leafy vegetables

Scheme and dosage of fertilizers in field experiment（kg/hm²）

Treatment	N	P_2O_5	K_2O	peat
K0	300	150	0	0
K1（KCl）	300	150	75	0
K2（KCl）	300	150	225	0
K3（KCl）	300	150	450	0
K4（K_2SO_4）	300	150	75	0
K5（K_2SO_4）	300	150	225	0
K6（K_2SO_4）	300	150	450	0
K7（K_2SO_4+peat）	300	150	225	2250

Study on leafy vegetables

response to different potassium fertilizer

Treatment of the highest increasing rate

10.7%～29.7%

Lettuce	K3(KCl) (kg/hm^2)	N	P_2O_5	K_2O
		300	150	450

4.32%～14.6%

Cabbage	K7(K_2SO_4 +peat) (kg/hm^2)	N	P_2O_5	K_2O	Peat
		300	150	225	2250

4.32%～14.6%

Romaine	K7(K_2SO_4 +peat) (kg/hm^2)	N	P_2O_5	K_2O	Peat
		300	150	225	2250

Conclusion

① No matter applied the KCl or K_2SO_4, 450 kg/hm^2 of K_2O is reommended.

Furthermore, the increasing effect of KCl is better.

② When applied 225 kg/hm^2 of K_2O, the yields of cabbage and romaine both up to the highest, the combination of organic fertilizer with chemical fertilizer could improve yield of vegetables.

③For romaine and cabbage, the efficient of increasing yield of KCl and K_2SO_4 have no significant difference. Considerting the price of market, KCl is more recommended.

2012.5-7

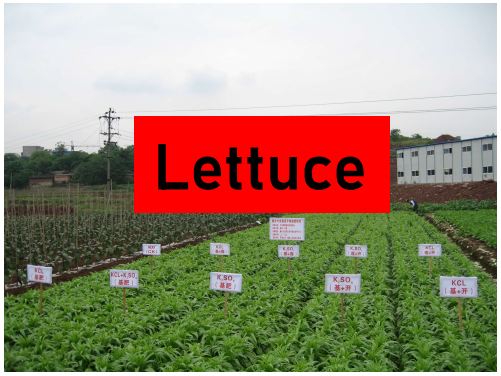
The test scheme of potassium fertilizer application

Serial number	Treatments	Code	Base fertilizer(%)	Rosette stage(%)	Heading stage(%)
1	No potash	K0	0	0	0
2	Conventional KCl	K1-1	100	0	0
3	Installment KCl	K1-2	50	50	0
4	Installment KCl	K1-3	50	0	50
5	Installment KCl	K1-4	0	50	50
6	Conventional K_2SO_4	K2-1	100	0	0
7	Installment K_2SO_4	K2-2	50	50	0
8	Installment K_2SO_4	K2-3	50	0	50
9	Installment K_2SO_4	K2-4	0	50	50

Study on leafy vegetables

response to different potassium application method

The first season



The second season

Split application > Basal applicaiton

Serial number	Treatments	Code	Base fertilizer(%)	rosette stage(%)	heading stage(%)	
1	No potash	K0	0	0	0	
2	Conventional KCl	K1-1	100	0	0	
3	Installment KCl	K1-2	50	50	0	
4	Installment KCl	K1-3	50	0	50	15.4%
5	Installment KCl	K1-4	0	50	50	
6	Conventional K_2SO_4	K2-1	100	0	0	
7	Installment K_2SO_4	K2-2	50	50	0	
8	Installment K_2SO_4	K2-3	50	0	50	
9	Installment K_2SO_4	K2-4	0	50	50	15.1%

Lettuce

Chinese cabbge

Study on leafy vegetables

response to **different potassium application method**

The preference K fertilizer of lettuce: KCl	**Prophase**
The preference K fertilizer of Chinese cabbage: K_2SO_4	**Late stage**

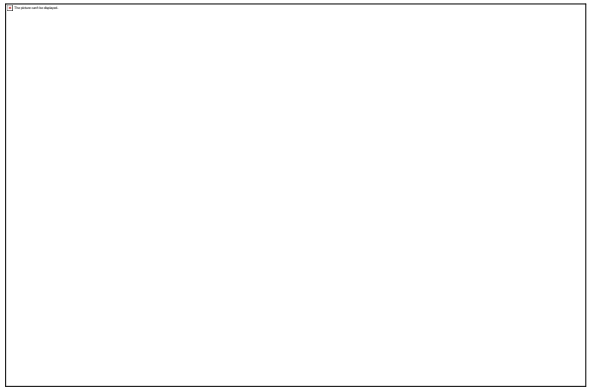
Lettuce	Base fertilizer(%)	Rosette stage(%)	Heading stage(%)
	50	**0**	**50**
Chinese cabbage	**0**	**50**	**50**

Scheme and dosage of fertilizers in field experiment（kg/hm^2）

Code	Treatment	fertilizer proportion	K_2O	Base fertilizer(%)	rosette stage(%)	heading stage(%)	vigorous growth stage(%)
CK_1	No potash	0	0	0	0	0	0
CK_2	Conventional potash	100%	150	100%	0	0	0
K_H	Reduced 10% potash and split application in root zone	90%	135	0	30%	30%	30%
K_L	Reduced 30% potash and split application in root zone	70%	105	0	23%	23%	24%

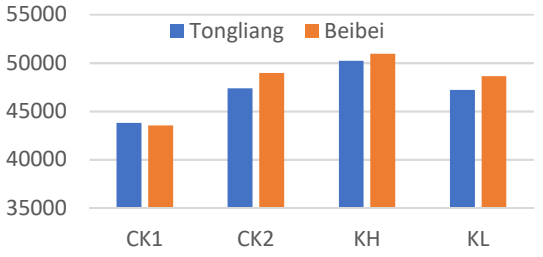
Effect of reduced K amount and split application in root zone of leafy vegetables

KCl、
K_2SO_4
KNO_3
Organic fertilizer of high potassium



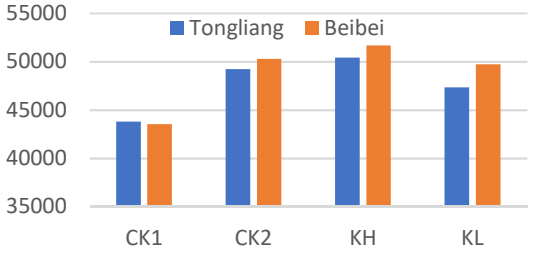
> KCl

Ø Reduced 10% KCl and 30% KCl improved the yield of lettuce in two sites, which of increase of **7.1%~8.4% and 10.0%~14.1%.**



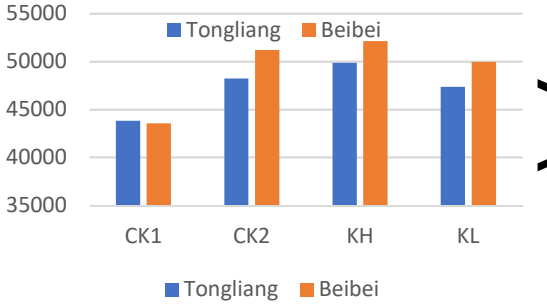
> K_2SO_4

Ø Reduced 10% K_2SO_4 and 30% K_2SO_4 improved the yield of lettuce in two sites, which of increase of **7.8%~14.7% and 11.7%~17.0%.**



> KNO_3

Ø Reduced 10% KNO_3 and 30% KNO_3 improved the yield of lettuce in two sites, which of increase of **8.1%~12.4% and 14.2%~15.5%.**



> OF of high K

Ø Reduced 10% OF of high K and 30% OF of high K improved the yield of lettuce in two sites, which of increase of **8.1%~13.8% and 14.7%~19.7%.**

Effect of
Organic fertilizer K replacing chemical potash fertilizer on leafy vegetables

Code	Treatment	K_2O (OF) (kg/hm^2)	K_2O (CF) (kg/hm^2)
CK_1	No potash	0	0
CK_2	Conventional potash	0	150
M_L+K_H	10% A-K+90% O-K	15	135
M_M+K_M	30% A-K+70% O-K	45	105
M_H+K_L	50% A-K+50% O-K	75	75
CK_1	No potash	0	0
CK_2	Conventional potash	0	150
M_L+K_H	10% B-K+90% O-K	15	135
M_M+K_M	30% B-K+70% O-K	45	105
M_H+K_L	50% B-K+50% O-K	75	75
CK_1	No potash	0	0
CK_2	Conventional potash	0	150
M_L+K_H	10% C-K+90% O-K	15	135
M_M+K_M	30% C-K+70% O-K	45	105
M_H+K_L	50% C-K+50% O-K	75	75

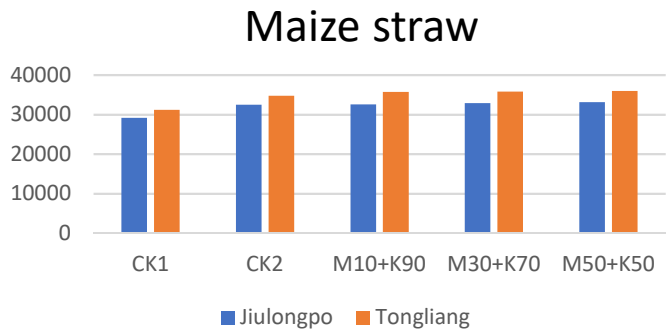
A: Maize straw

B: organic fertilizer of high K

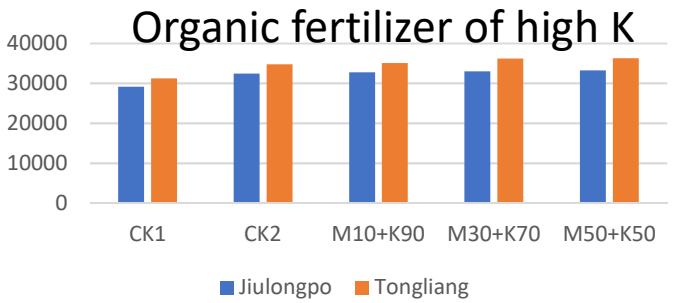
C: Commercial organic fertilizer

O: Chemical fertilizer

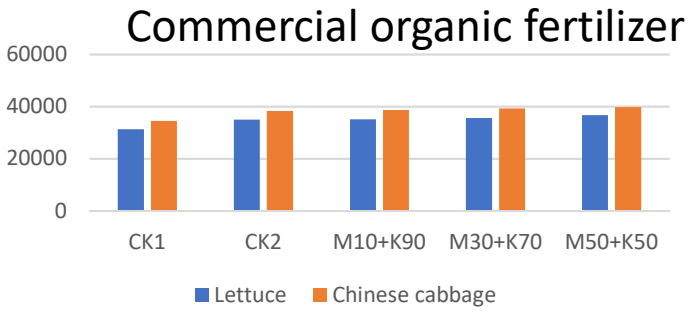
The inceasing rate		Recommened treatment
Jiulongpo	Tongliang	$M_{50}+K_{50}$
11.4%～13.7%	11.4%～15.3%	



The inceasing rate		Recommened treatment
Jiulongpo	Tongliang	$M_{50}+K_{50}$
11.4%～13.9%	11.4%～16.3%	



The inceasing rate		Recommened treatment
Lettuce	Chinese cabbge	$M_{50}+K_{50}$
11.6%～17.4%	10.9%～15.4%	



50% maize straw K+50% chemical fertilizer K is recommened for lettuce planted.

Demonstration

Demonstration of K reduction and split application in root zone

Treatments	Content of available K in soil (mg/kg)
KCl reduction of 10%	131
KCl reduction of 30%	165
K_2SO_4 reduction of 30%	118
KNO_3 reduction of 30%	211
	402

Demonstration

Demonstration test
Address: Tongnan、Beibei
Vegetable: Lettuce

Content of available K in soil (mg/kg)	Treatment	Yield (kg/hm^2)
131	Conventional potash	36407
	KCl reduction of 10%	38047
	KCl reduction of 30%	37130
165	Conventional potash	31149
	KCl reduction of 10%	32461
	KCl reduction of 30%	31860

Ø KCl reduction of 10%~30% and split application in root zone can be applied in lettuce practically.

Demonstration test
Address: Tongliang、Beibei
Vegetable: Cabbge、Lettuce

Vegetables	Content of available K in soil (mg/kg)	Treatment	Yield (kg/hm^2)
Lettuce	118	Conventional potash	35445
		KNO_3 reduction of 30%	35999
Cabbage	165	Conventional potash	91220
		KNO_3 reduction of 30%	95445

Ø The increasing yield efficient of KNO_3 reduction in cabbage is better.

Ø Within KNO_3 reduction of 30%, the yield of vegetables varies unobviously.

Ø KNO_3 is suitable for top dreassing in vegetable production.

Demonstration test
Address: Tongnan、Tongliang、Beibei
Vegetable: Chinese cabbage、Cabbage、Lettuce

Vegetables	Content of available K in soil (mg/kg)	Treatment	Yield (kg/hm^2)
Cabbage	165	Conventional potash	91220
		K_2SO_4 reduction of 30%	96975
Lettuce	211	Conventional potash	34755
		K_2SO_4 reduction of 30%	34245
Chinese cabbge	402	Conventional potash	78570
		K_2SO_4 reduction of 50%	83430
		K_2SO_4 reduction of 100%	80370

Ø **In the high K nutrient of vegetable planted soil, we should significantly reduce potassium application, even not apply potash.**

Demonstration

Demonstration of organic fertilizer replacing chemical fertilizer

Recommended model of OF replacing CF	Dosage of K nutrient	
$OF_{50\%}+CF_{50\%}$	K_2O(OF)	K_2O(CF)
	75	75

The selected fertilization program is recmmoned on the cultivation of leafy vegetable in Chongqing

OF: Oraganic fertilizer
CF: Chemicl fertilizer


甘蓝钾肥高效利用示范试验
SRF
（28-10-9）
SCF
（28-10-9）
Ks+NM
（28-10-9）
CF
（28-10-13）


重庆蔬菜钾肥高效施用技术研究
（201203013-5）


重庆蔬菜钾肥高效施用技术研究
（201203013-5）


钾肥对蔬菜安全品质的影响研究
N20P10K0
(C1)N0P0K0
(C1)N0P0K0
(C1)N0P0K0
(C1)N0P0K0


甘蓝钾肥高效利用示范试验
KN
（28-10-9）
KN+NM
（28-10-9）
KS
28-10-9）
KS+NM
（28-10-9）
KS+SCF
（28-10-9）
CF
（28-10-13）


重庆蔬菜钾肥高效施用技术研究
（201203013-5）


重庆蔬菜钾肥高效施用技术研究
（201203013-5）


常规施硝酸钾

2019
Kunming

Thank you