Potassium and plant health

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Outline

- Review on role of K nutrition in resistance to diseases
- Current results of our group

K enhances plant resistance to many diseases

- Maize stalk rot (Li et al，2004；Heckman，1998)
- Wheat powdery mildew（Bhaakar, 2001;Kettlewell, 2000）
- Rice stalk rot (Williams, 2001）
- Wheat leaf blight, Cotton leaf spot (Sharma et al, 1994, 2005)
- Rapeseed black spot（Sharma et al, 1994）

K and wheat leaf blight

Given that controlling HLB through fungicide application is costly and frequently unaffordable to resource-poor farmers, disease reduction through adequate K_2O fertilization could be a viable alternative to using fungicide.

Since there is a lack of information on the effect of potassium fertilization and HLB interactions on wheat performance in rice–wheat cropping systems and non-traditional warmer growing regions, this study was conducted to determine their combined effect on grain yield and thousand-kernel weight (TKW) of three wheat varieties under severe natural disease pressure. This information is essential for developing an integrated crop management strategy that will reduce wheat yield losses due to HLB on resource-poor farms.

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Field Crops Research 93 (2005) 142–150

Effect of potash fertilization on Helminthosporium leaf blight severity in wheat, and associated increases in grain yield and kernel weight

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K and wheat leaf blotch

Plant Pathology (2004) 53, 653–659 Doi: 10.1111/j.1365-3059.2004.01063.x

Effect of foliar-applied potassium chloride on septoria leaf blotch of winter wheat

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Discussion

benefits. If potassium chloride was applied instead of a fungicide, or was tank-mixed with a reduced dose of fungicide, there would be no extra cost for this application.

K and maize stalk rot

吉林农业大学学报 2004 ,26(4) :360～362
Journal of Jilin Agricultural University

应用足量钾肥和高效种衣剂防治玉米茎腐病的试验研究*

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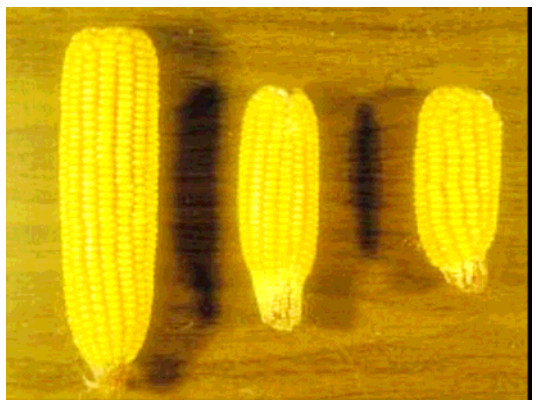
摘 要: 试验研究了不同钾肥施用量与玉米茎腐病发生的关系及种衣剂结合增施钾肥对茎腐病的防治效果。结果表明:增施钾肥可增强植株的抗性,降低玉米茎腐病的发病率。随着钾肥施用量的增加,玉米茎腐病的发病率逐渐降低,而对玉米茎腐病的防治效果逐渐提高。以钾肥施用量 150 kg/hm^2 防治效果最好,质量分数为 2.5 %适乐时悬浮种衣剂与钾肥 150 kg/hm^2 结合施用对玉米茎腐病防效达 87.40 %。

关键词: 玉米茎腐病; 钾肥; 种衣剂
中图分类号: S435.131 **文献标识码**: A **文章编号**: 1000-5684(2004)04-0360-03

Lodging



Yield loss

Spike rot

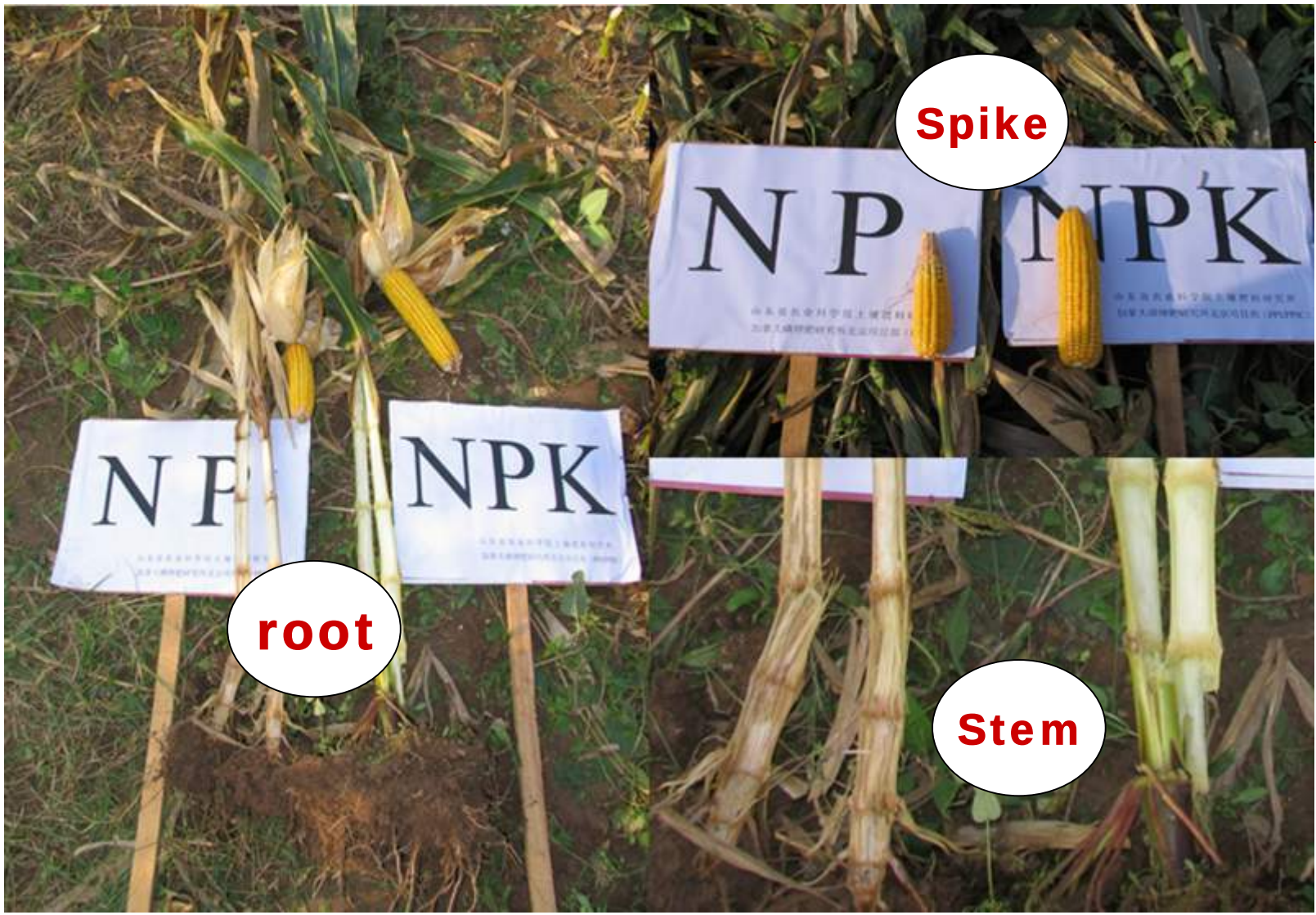
Stalk lodging in Liaoning (2006)

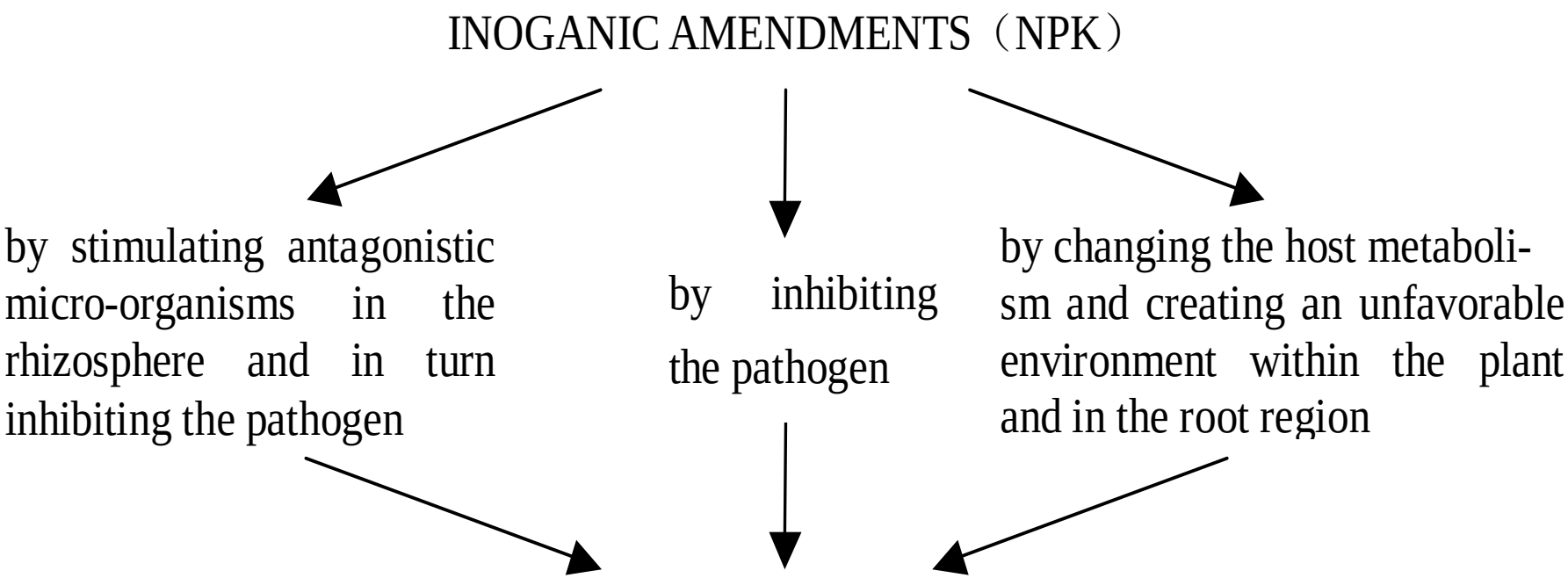
土壤速效钾？？？

K role in stalk rot resistance in Shandong(2005)

2005年山东省海阳市赵疃乡杜格庄

土壤速效钾？？？


Spike
NP
NPK
NP
NPK
root
Stem



Control by combined effect,

i.e. by changing the host metabolisms, inhibiting the pathogen directly and by stimulating antagonistic microflora in the rhizosphere

Dutta B K, Isaac I. Plant and soil. 1979,52(4): 561-569

Sucrose content and maize stalk rot

第 31 卷 第 4 期 西北农林科技大学学报(自然科学版) Vol. 31 No. 4
2003 年 8 月 Jour. of Northwest Sci-Tech Univ. of Agri. and For. (Nat. Sci. Ed.) Aug. 2003

Relationships between sucrose content and resistance of corn to stalk rot

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[**Abstract**] The relationship between sucrose content and corn resistance to corn stalk rot caused by *Fusarium graminearum* was investigated. The incidence of corn stalk rot was closely related to sucrose content in the pith tissues of the second internode above the ground at the physiological maturity stage. Corn hybrids resistant to stalk rot had higher sucrose contents in the pith tissues of the second internode above the ground than hybrids susceptible to the disease. In addition, disease incidence was negatively correlated with sucrose content in the pith tissues of the second internode above the ground at the physiological maturity stage. The results suggested that sucrose content could be used as an indicator of corn stalk rot resistance and for selecting corn hybrids for resistance to corn stalk rot.

[**Key words**] sucrose content; resistance; corn stalk rot; *Fusarium graminearum*

Sucrose content in the pith tissues of the second internode above the ground at physiological maturity stage could be used as an indicator of corn stalk rot resistance

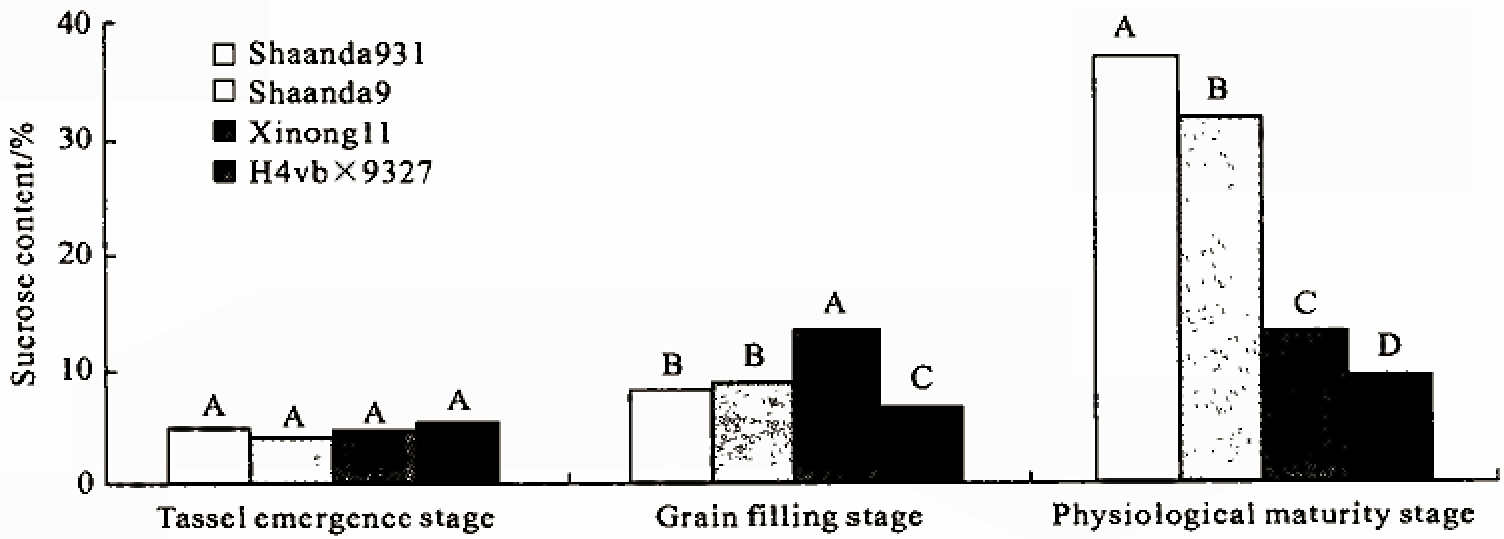
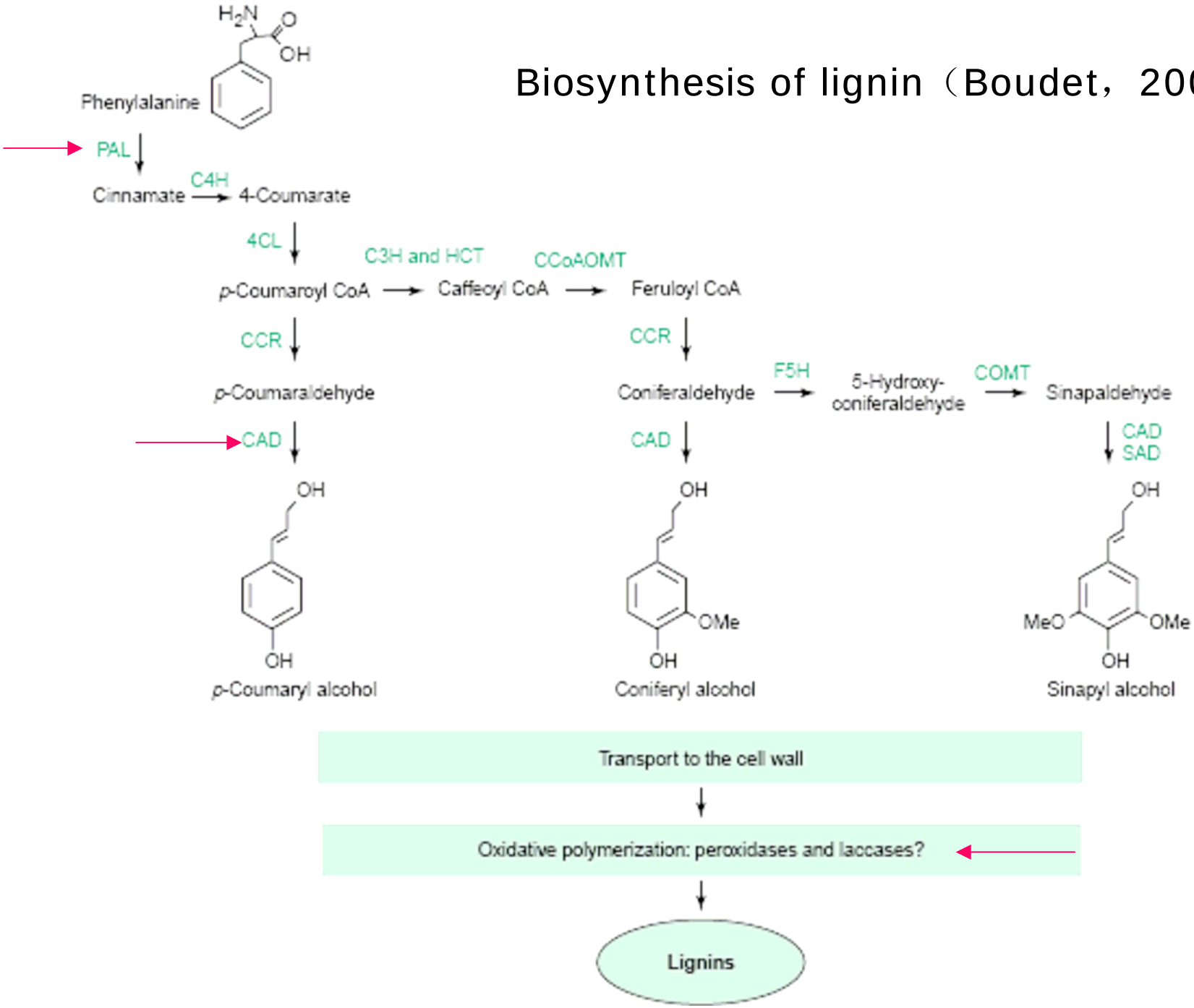


Fig. 2 Sucrose content in the second internode above the ground at different growth stages

Each value represents the average of three replicates

Long et al., 2003

Biosynthesis of lignin（Boudet，2003）



PAL activity and maize stalk rot

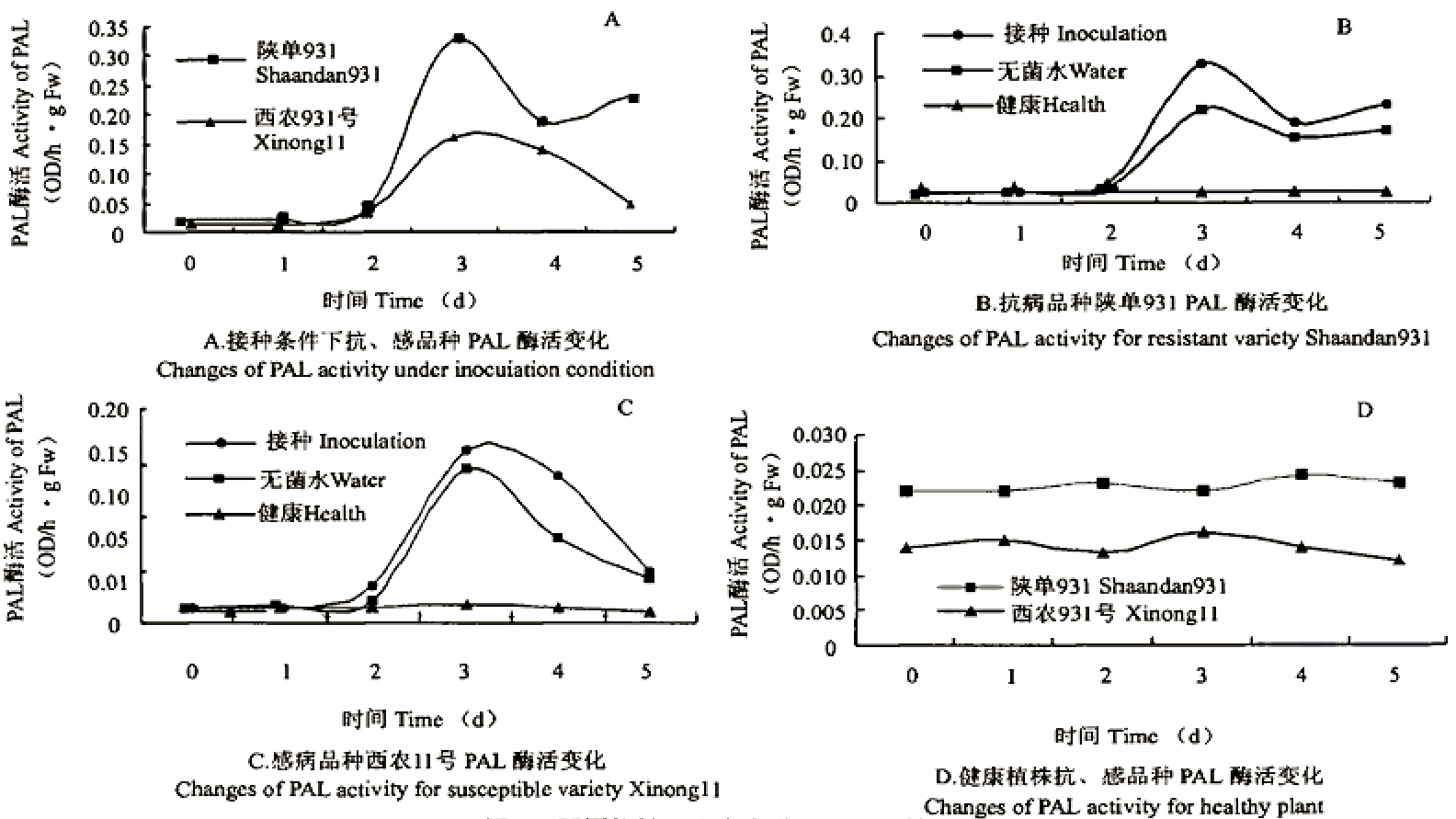


图 1　不同抗性玉米杂交种 PAL 酶活性

A. 健康植株抗、感品种 PAL 酶活变化；B. 接种条件下抗、感品种 PAL 酶活变化；C. 抗病品种陕单 931 PAL 酶活变化；D. 感病品种西农 11 号 PAL 酶活变化

Fig. 1　PAL activity of resistant and susceptible hybrids

A. Changes of PAL activity for healthy plant; B. Change of PAL activity under inoculation condition; C. Changes of PAL activity for resistant variety Shaandan 931; D. Change of PAL activity for susceptible variety Xinong 11

Li et al.,2003

Lignin content and maize stalk rot

Changes of lignin in different varieties after infection

品种	处理	木质素含量（g/kg）				
		1d	2d	3d	4d	5d
陕单 931	接种	6.44	7.97	9.30	10.89	11.06
	健康	4.92	5.01	5.05	5.06	5.08
	净增加值	1.52	2.96	4.25	5.83	5.98
西农 11 号	接种	9.25	11.44	11.78	11.10	10.25
	健康	7.75	7.78	7.81	7.80	7.79
	净增加值	1.54	3.66	3.97	3.30	2.46

注：净增加值＝接种植株 - 健康植株

李亚玲等.,2005

PAL metabolism and maize stalk rot

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2004年9月 Jour. of Northwest Sci-Tech Univ. of Agri. and For. (Nat. Sci. Ed.) Sep. 2004

玉米苯丙烷类次生代谢物与玉米对茎腐病抗性的关系*

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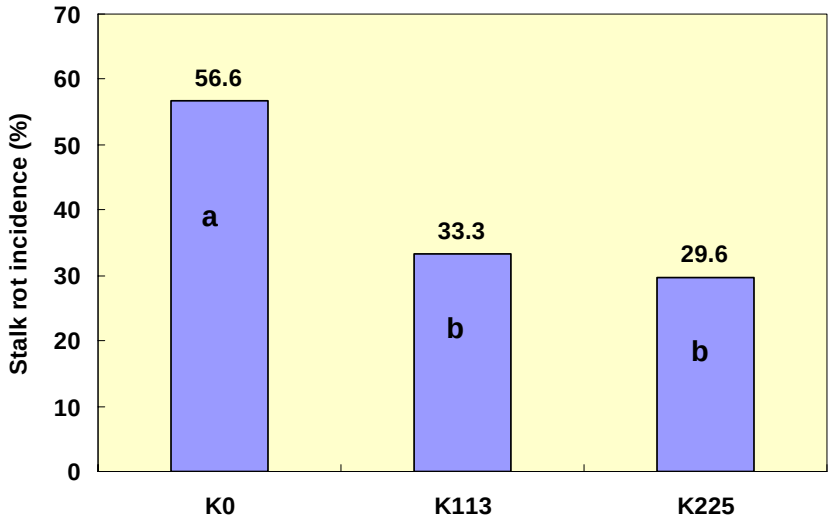
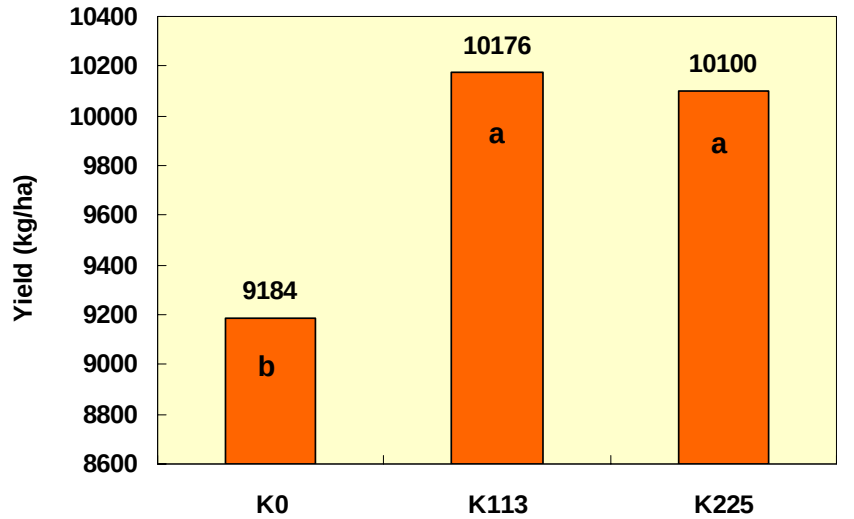
2 郑州市蔬菜研究所, 河南 郑州 450015)

[摘 要] 对抗病玉米品种陕单931和感病玉米品种西农11号在抽雄初期接种禾谷镰刀菌孢子悬浮液, 于接种后测定茎秆髓部组织内苯丙烷类次生代谢物木质素和绿原酸的变化。结果表明, 玉米植株原生木质素与玉米对茎腐病的抗性无关, 仅诱导产生的木质素在玉米的抗病性中起作用。并证实玉米植株受到镰刀菌侵染后可产生对镰刀菌有抑制作用的物质。

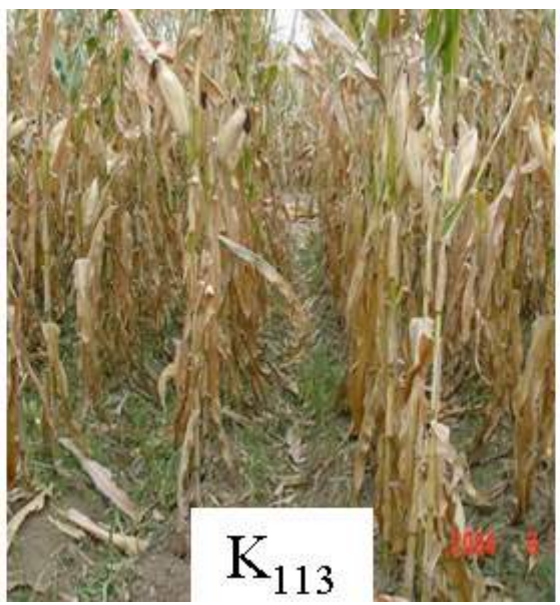
[关键词] 玉米茎腐病; 抗性; 木质素; 绿原酸
[中图分类号] S432.2+3; S435.131.4+9 [文献标识码] A [文章编号] 1671-9387(2004)09-0093-04

Our results


Stalk rot incidence (%)
70
60
50
40
30
20
10
0
56.6
a
33.3
b
29.6
b
K0
K113
K225

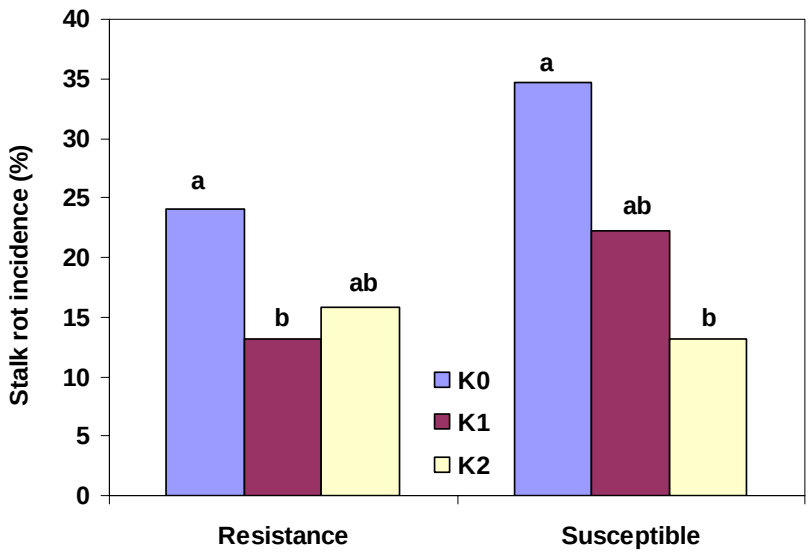

Yield (kg/ha)
10400
10200
10000
9800
9600
9400
9200
9000
8800
8600
9184
b
10176
a
10100
a
K0
K113
K225

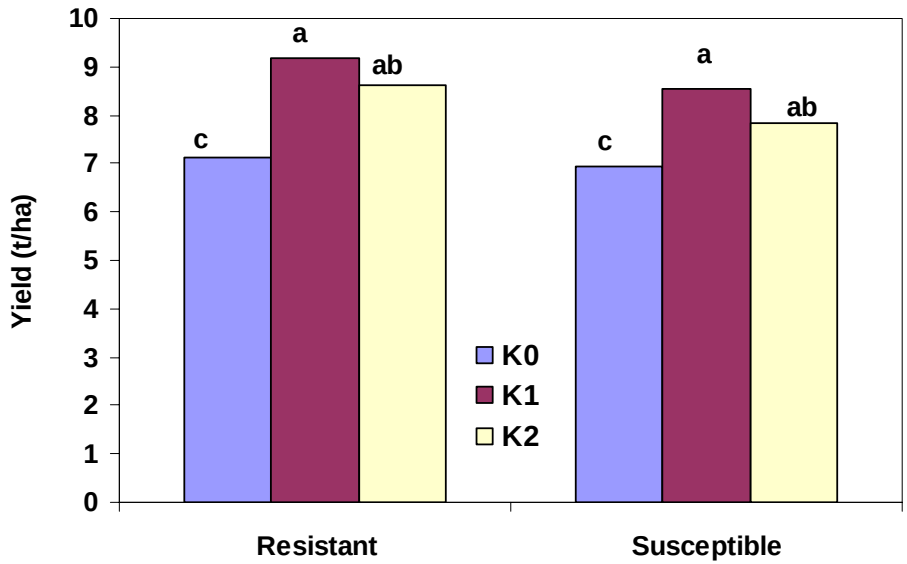

K0


K113

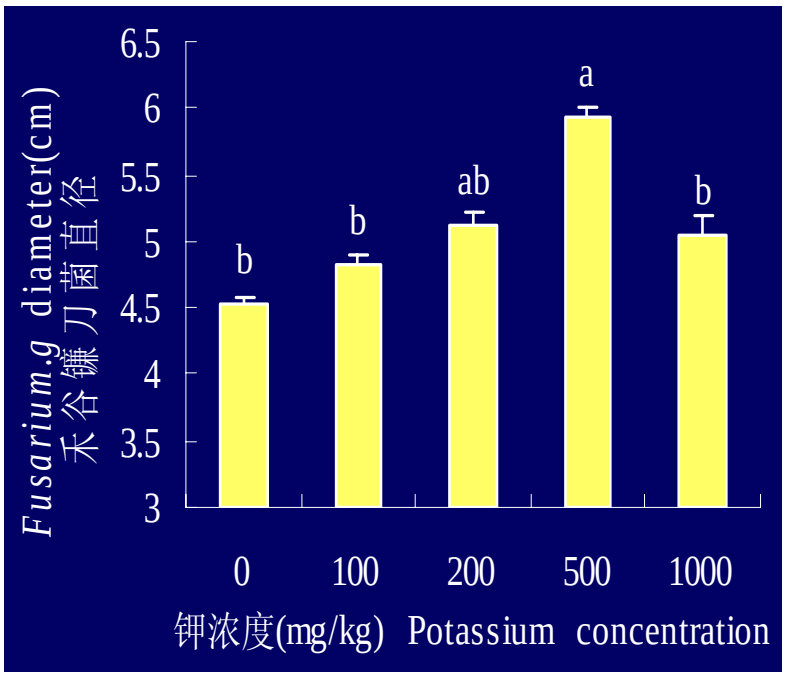

K225

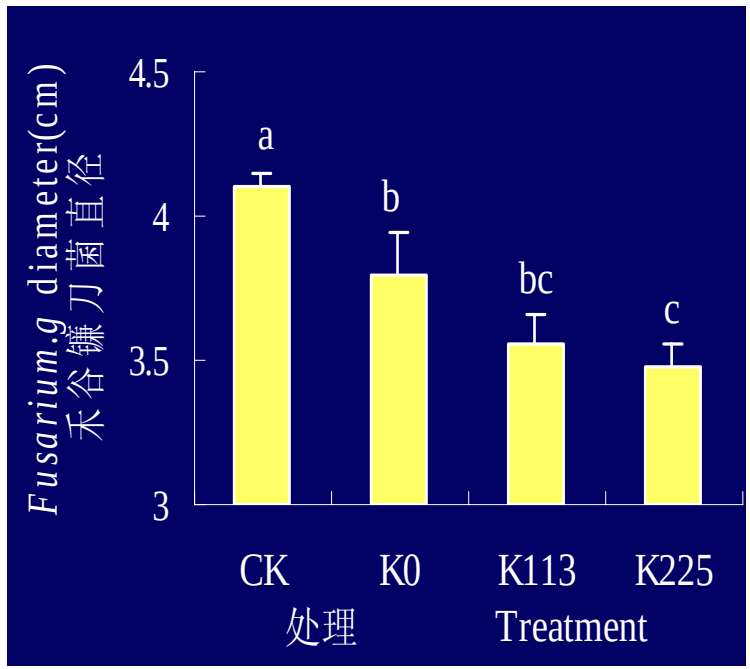
K effect on incidence and yield（Jilin，2005）





KCl could not inhibit pathogen growth directly





K promoted growth of pathogen, but soil extract from K treatment inhibited growth of pathogen

K deficiency induced sugar secretion

表 3 钾对玉米根系糖分泌量的影响(μg/plant/h)

Table3 Effect of potassium on sugar content in maize root exudates (μg/plant/h)

处理 Treatment	吉单327 Jidan327			吉单180 Jidan180		
	总糖 Total sugar	还原糖 Reducing sugar	蔗糖 Sucrose	总糖 Total sugar	还原糖 Reducing sugar	蔗糖 Sucrose
CK	18.60 ± 1.29	10.08 ± 0.26	8.09 ± 1.04	15.41 ± 0.95	7.67 ± 0.21	7.35 ± 0.44
KCl	10.85 ± 1.34	2.44± 0.34	7.98± 0.65	9.00 ± 1.06	1.34 ± 0.12	7.27 ± 0.41

Addition of sugar promoted growth of Fg.

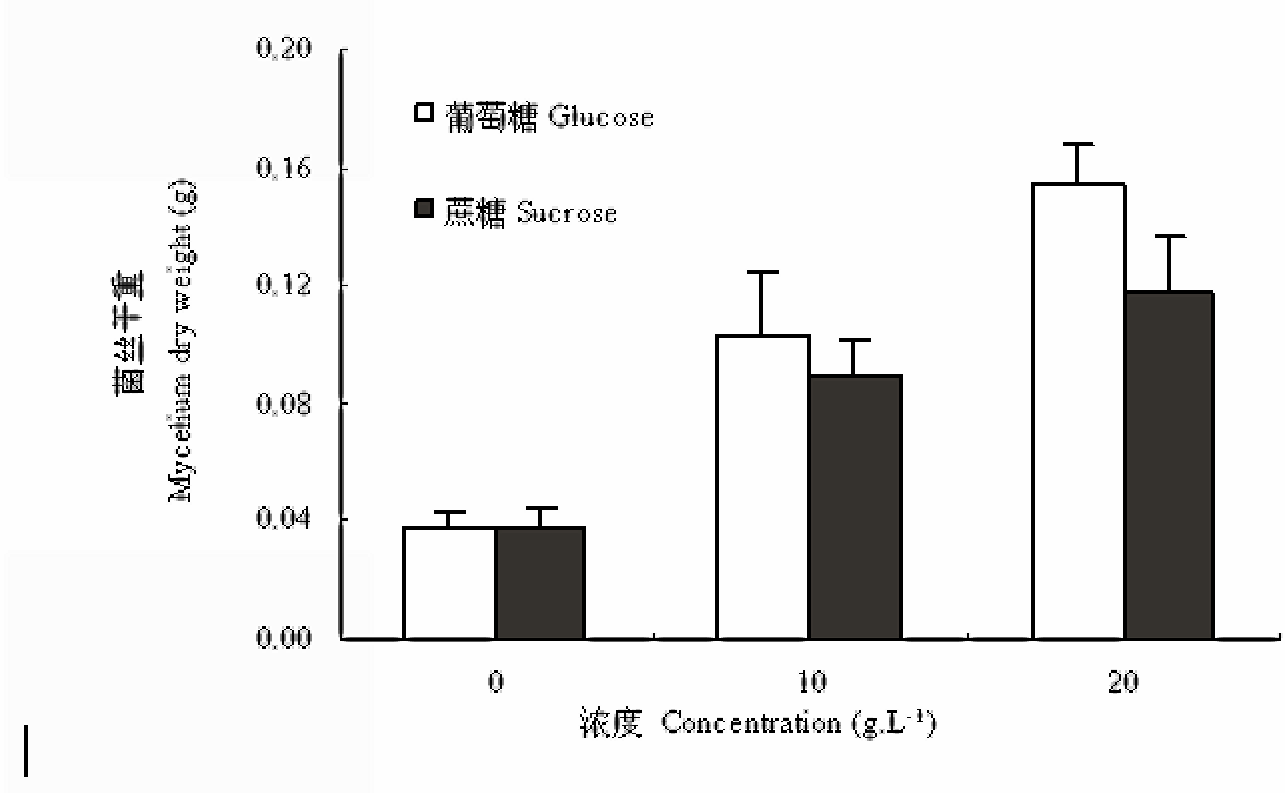


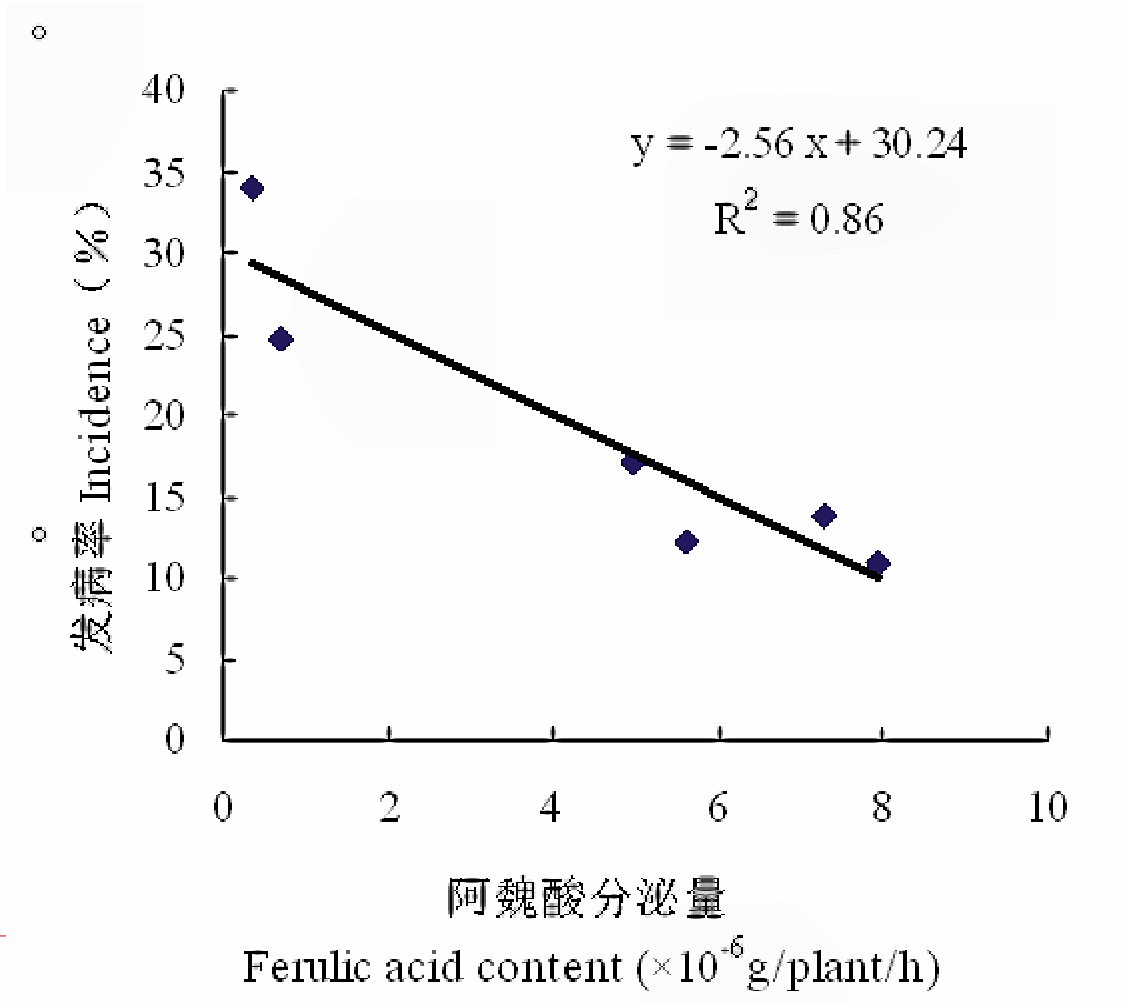
图 3 葡萄糖和蔗糖对禾谷镰刀菌生长的影响

Fig. 3 Effect of glucose and sucrose on the growth of *F. graminearum*

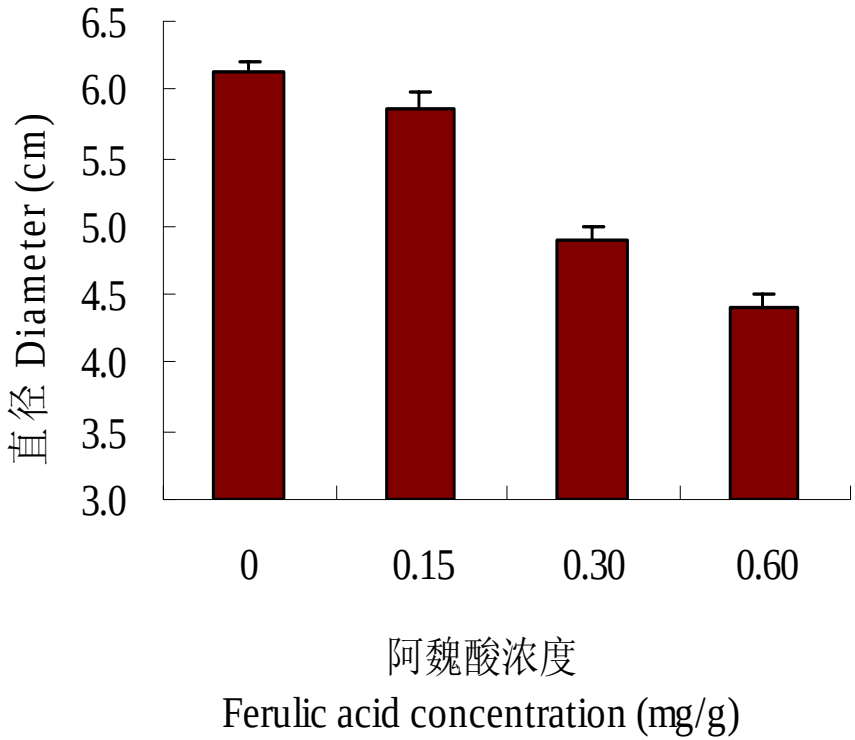
KCl promoted ferulic acid secretion

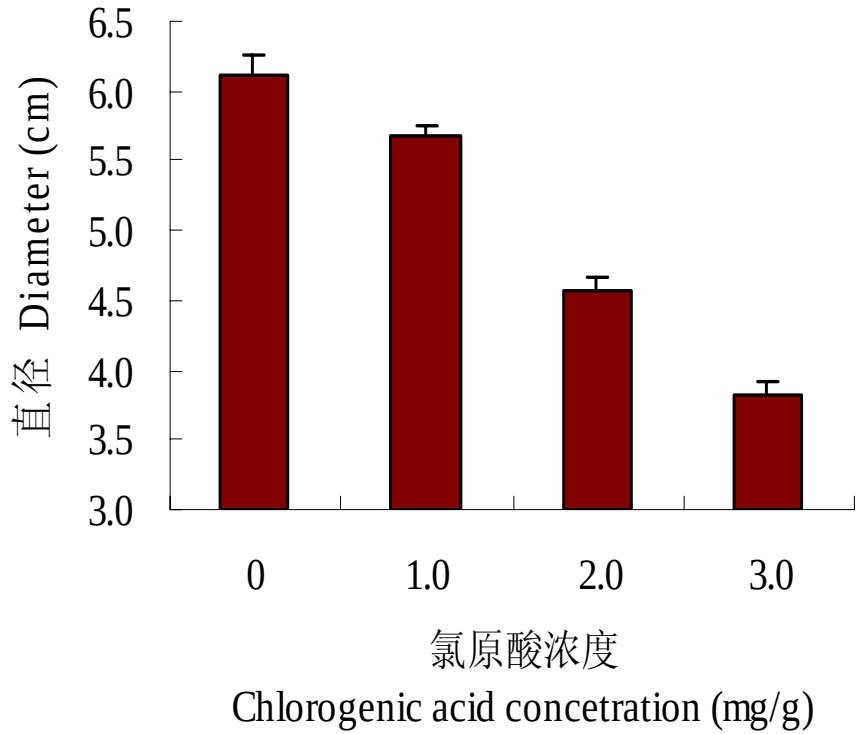
品种	处理	阿魏酸 (μg/plant/h)	绿原酸 (μg/plant/h)
吉单180	CK	0.68	1.11
	KCl	7.93	0.75
吉单327	CK	0.35	3.27
	KCl	5.63	2.46

Furulic acid had a negative correlation to incidence



Phenol effect on Fg



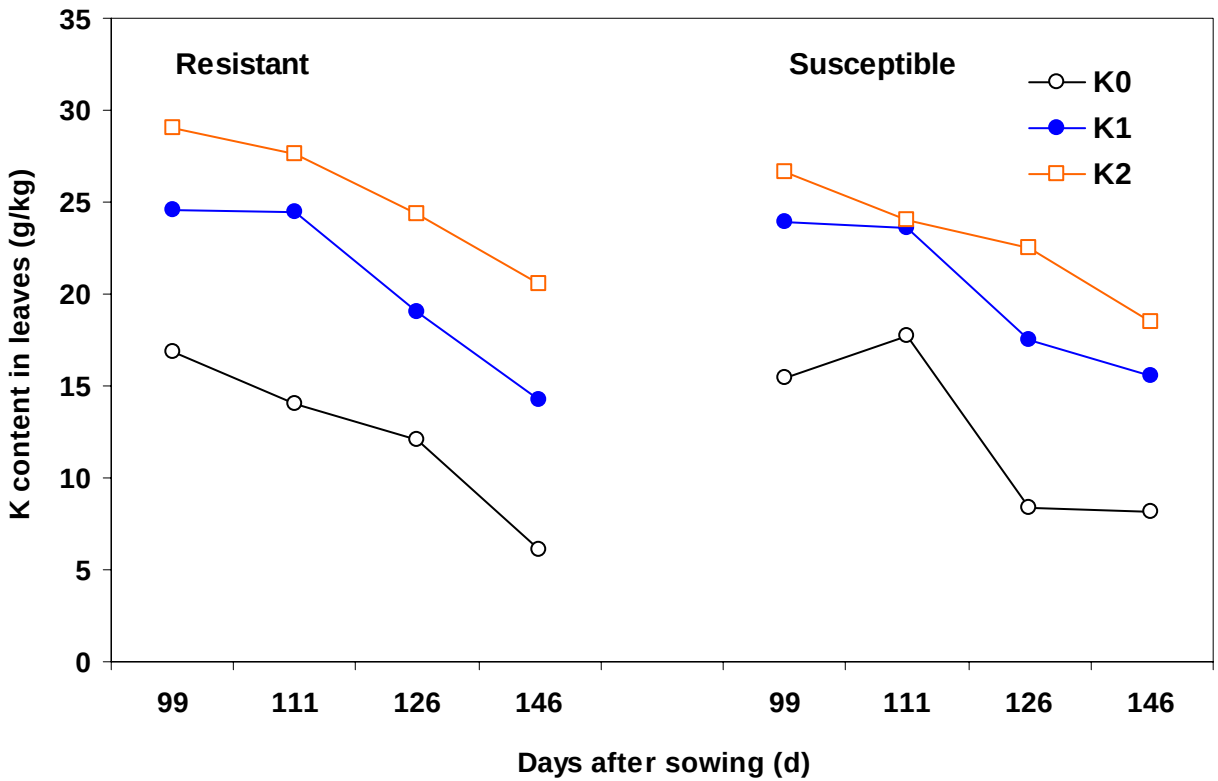


阿魏酸对Fg生长繁殖的抑制作用〉〉氯原酸，氯原酸抑菌浓度>>阿魏酸。氯原酸刺激Fg孢子萌发（徐茂，1992）

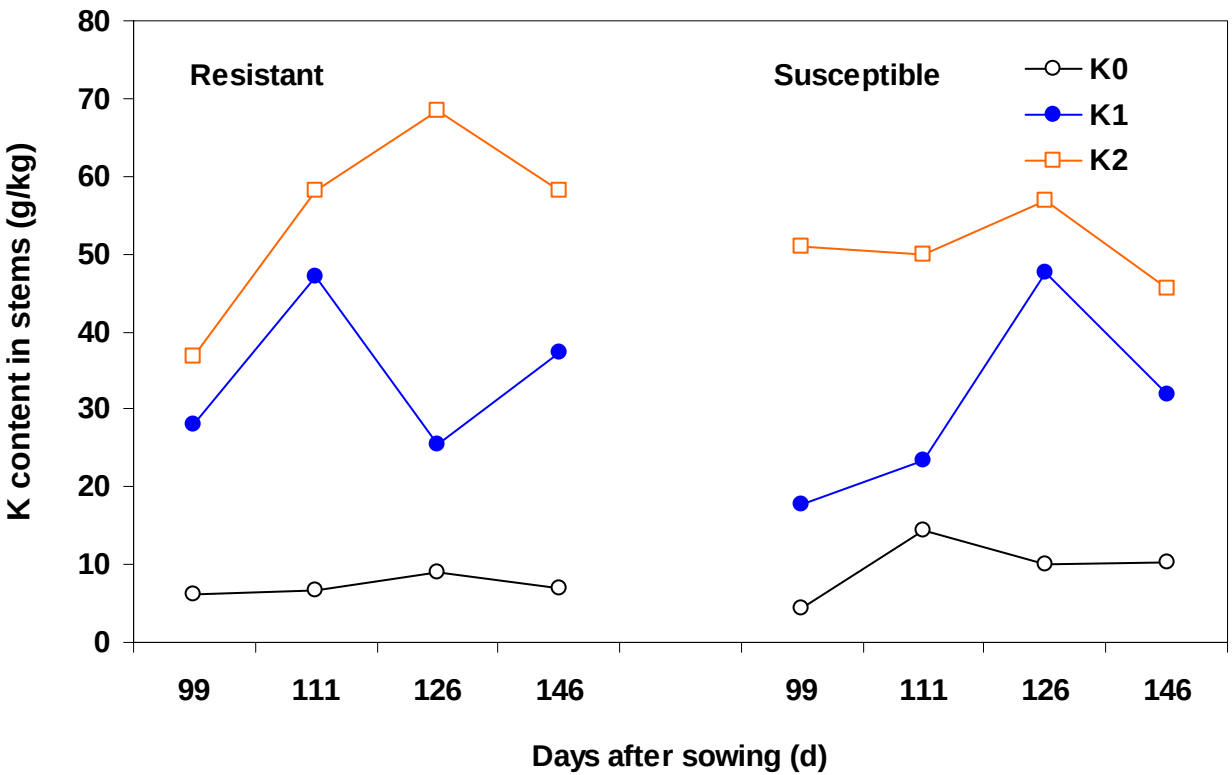
Potassium promoted secretion of organic acid in root exudates

品种	处理 Treat.	草酸 Oxalic acid	酒石酸 Tartaric acid	苹果酸 Malic acid	乳酸 Lactic acid	柠檬酸 Citric acid	Σ
		(μg/plant/h)					
吉单180	CK	6.24	0.88	2.39	0.86	0.07	**10.77**
	KCl	3.56	1.85	2.07	2.86	0.31	**12.32**
吉单327	CK	4.95	0.37	6.21	0.22	0.16	**11.92**
	KCl	9.17	0.90	4.36	0.73	0.86	**16.02**

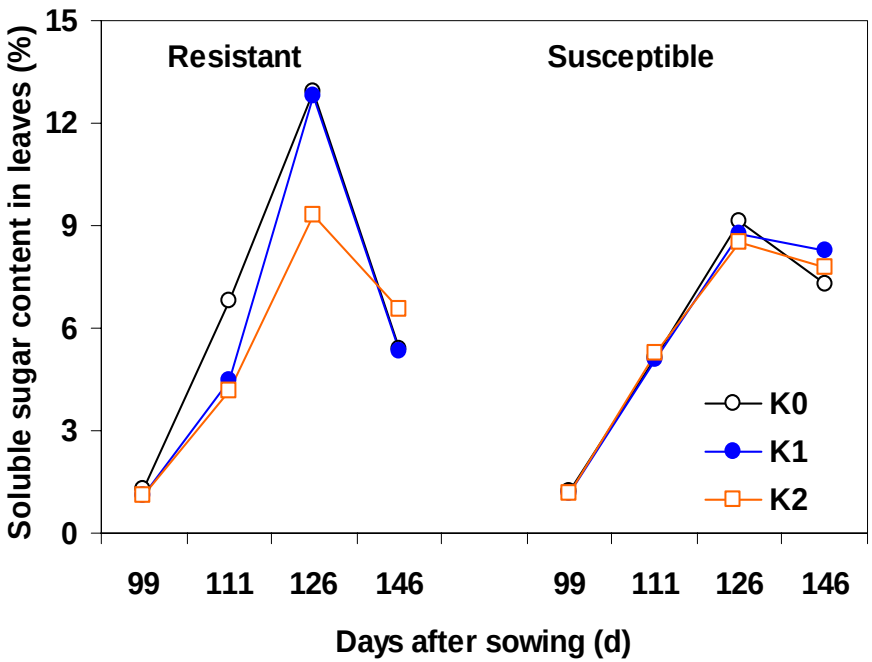
K increased K content in ear leaf

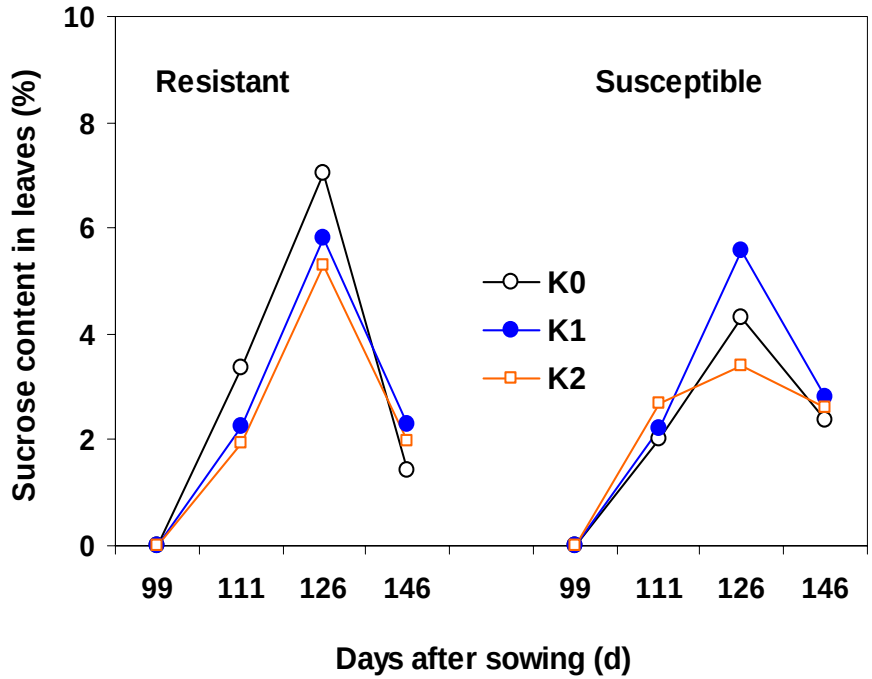


K increased K content in the pith tissues of the second internode above the ground

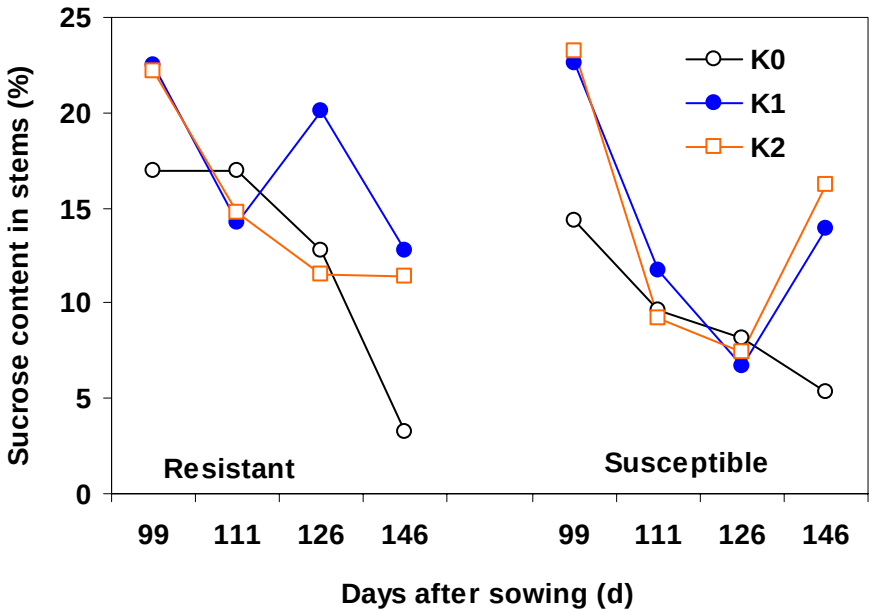


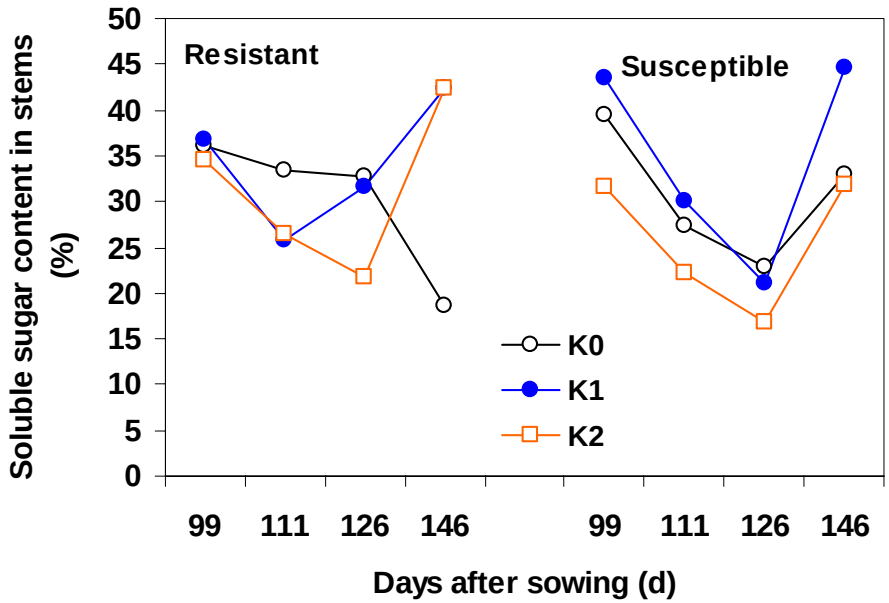
K enhanced sugar content at maturity



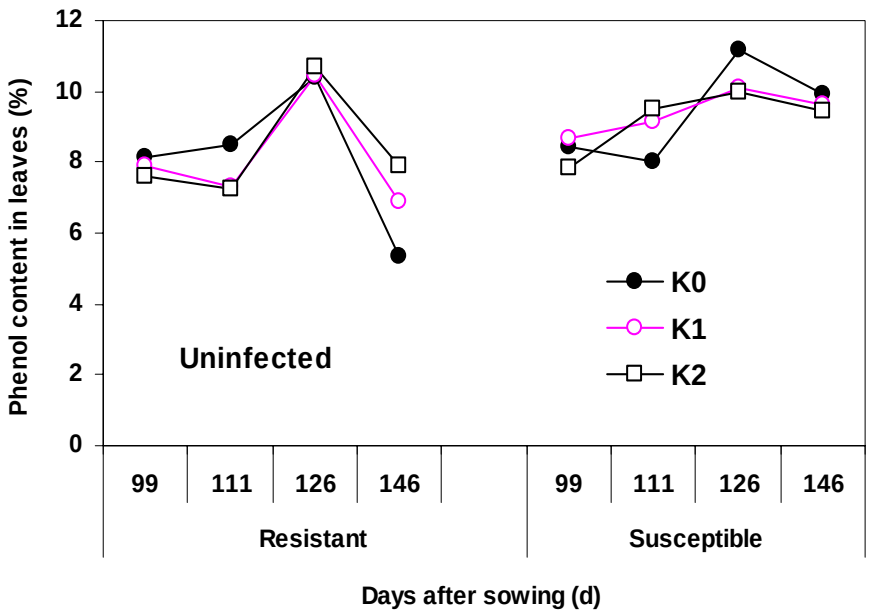


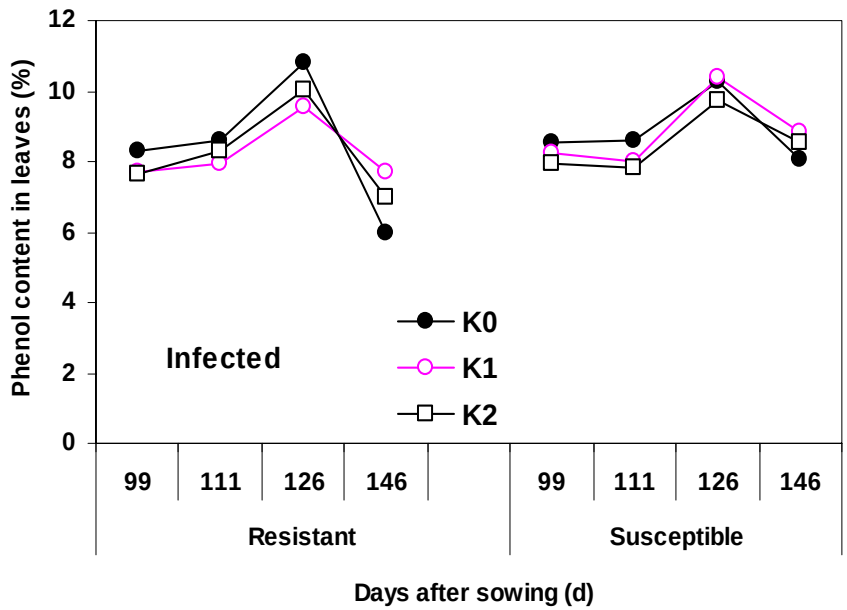
K increased sugar content in the pith tissues of the second internode above the ground



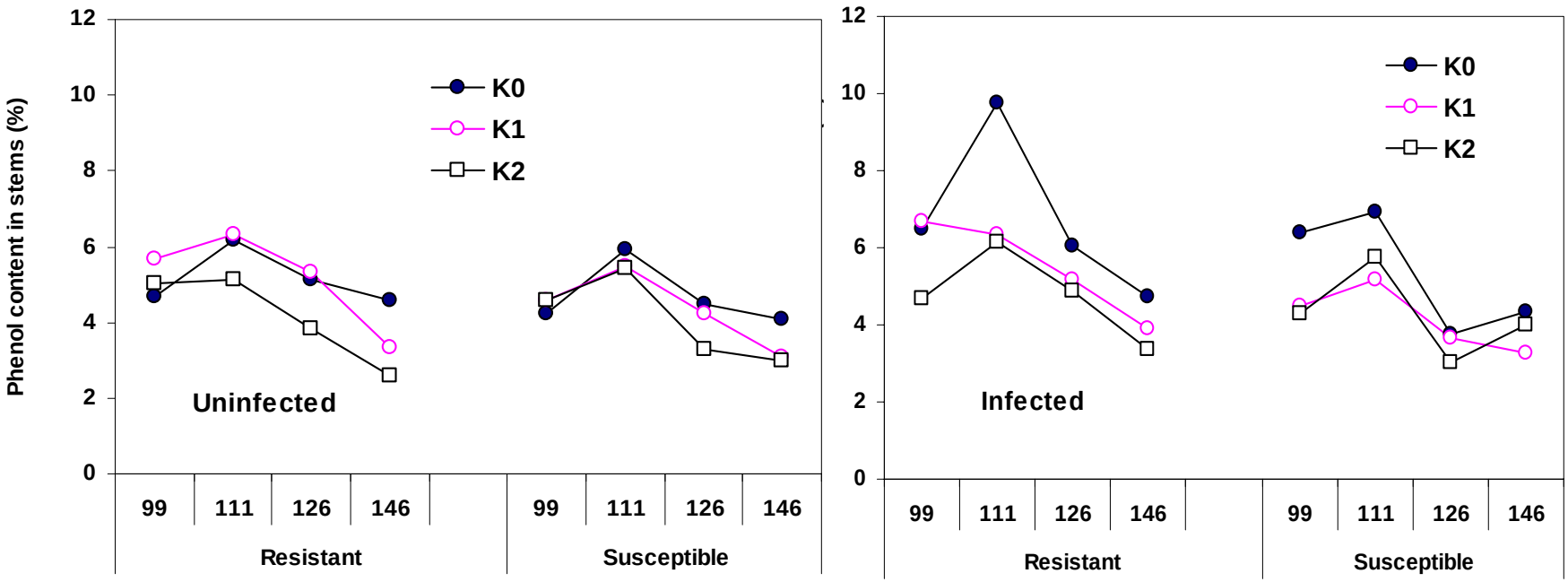


K enhanced phenol content in ear leaf

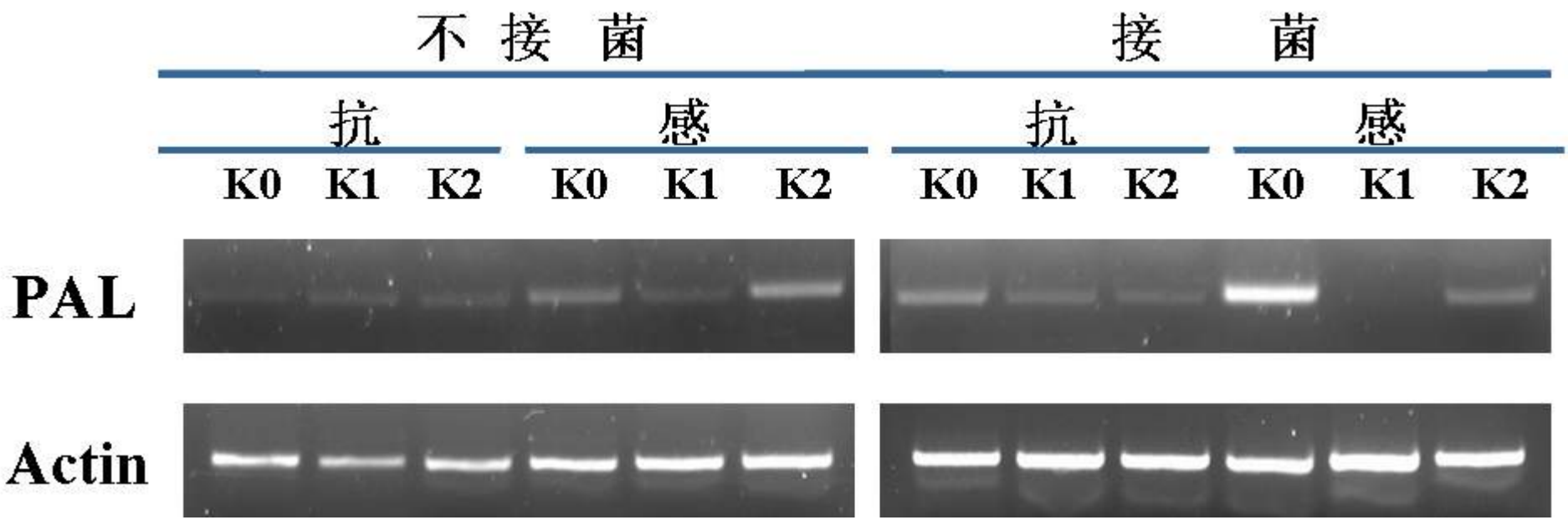




Phenol increased after infection at maturity, K decreased phenol content in the pith tissue



PAL gene expression



Conclusion I

- K decreased incidence of maize stalk rot, and therefore increased yield;
- Mechanism：
  - K could not inhibit growth of Fg directly;
  - Root exudates: K reduced sugar, but enhanced phenol and organic acid;
  - Metabolism regulation：
    - Primary metabolism：K enhanced sugar content in ear leaf and 2nd pith tissue;
    - Secondary metabolism：K increased phenol content in ear leaf , but decreased phenol content in pith tissue. There is no corelation between phenol content in 2nd pith tissue and incidence to stalk rot? (Ruiz, 1999; PetkovŠek,2003)
- Related mechanism need to be furthered

Conclusion II

- Relationship between plant nutrition and plant pathology is a crossing and hot research area, more attention need to be paid to;
- The main point of this study is to control disease with balanced fertilization with K instead of fungicide to protect environment.

Thank you!