# Release of soil K in $NaBPh_4$ solution and a modified method for measuring soil available K

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# Content

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- Release of soil K in $NaBPh_4$ solution under different condition
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- Conclusion

# Principle of $NaBPh_4$ method

$K^+ + NaBPh_4 \longrightarrow KBPh_4 \downarrow + Na^+$ （$s = 1.8 \times 10^{-5}$ mol $L^{-1}$)

- Very low solubility, facilitated the release of fixed K;
- Slight destruction to the original mineral;
- The easily released K will firstly be extracted;
- Under different conditions, the different fractions of soil K could be released

# History of $NaBPh_4$ method

- Was firstly proposed in 1954（Hanway，1956）；
- Scott  and Reed (1962):

  Addition of  EDTA to stabilize of $NaBPh_4$,

  Using 0.5M $NH_4Cl$ and heating to dissolve $KBPh_4$,
- Reed and Scott (1961):

  Using $HgCl_2$ to accelerate decomposing of $KBPh_4$
- Cox et al. (1996):  Using $CuCl_2$ instead of $HgCl_2$

# Application of $NaBPh_4$ method

- Was mostly used for extraction of non-exchangeable K especially in various kinds of clay minerals such as vermiculite, illite, biotite, phlogopite, muscovite and so on in the early research;
- It was used for soil testing in the recent years. Cox et al. (1999) found that amount of K extracted with 1.7MNaCl-0.01MEDTA-0.2M $NaBPh_4$ for 1 min had a very good correlation to the K uptake of plant;

# Application of $NaBPh_4$ method

- Based on the recovery of external added K and the amount of K exhausted in the soils of long-term field experiment, we established a method to quantifying the change of soil K:

0.500 g soil + 3 ml $NaBPh_4$ solution (1.7 M NaCl + 0.25 M $NaBPh_4$ + 0.01 M EDTA)，shake for 24 h at 25℃.

As the soil K changed after exhaustion or fertilization, the amount of changed K could be quantified by measuring the change of $NaBPh_4$-extracted K between original and K-changed soil.

# Application of $NaBPh_4$ method

- The total non-exchangeable K (NEK) released by $NaBPh_4$ is limited in the soils, it would not increase as the extraction period further increased. A method for quantifying the total NEK in the soil was also established:

  0.500 g soil + 3 ml $NaBPh_4$ solution (1.7 M NaCl + 0.25 M $NaBPh_4$ + 0.01 M EDTA)，shake for over 10 d at 45℃ or for over 20 d at 25℃.

# Purpose of current research

Most of $NaBPh_4$ method extracted too much of soil K. Current research aimed to investigate the release of soil K in $NaBPh_4$ solution with low extracting power and to find a proper method for evaluation of soil available K.

# Material and method

## Basic information for the four soils tested

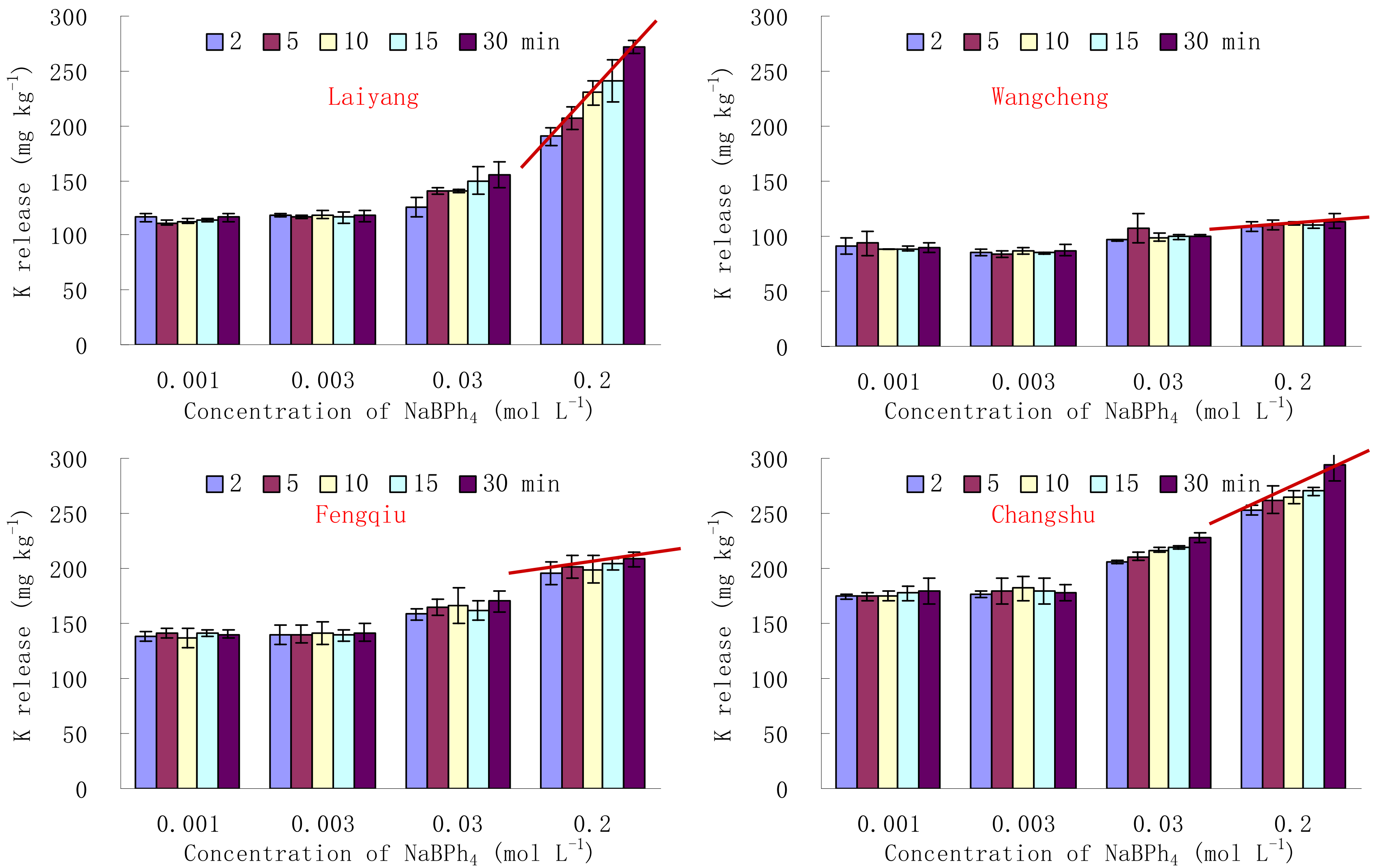
| Site | Soil type | Parent meterial | pH (1:1 $H_2O$) | Main clay minerals | Crops |
|---|---|---|---|---|---|
| Laiyang, Shandong | Fluvo-aquic soil | Fluvial deposits | 6.80 | HM, VC, KK, SM | wheat-maize |
| Wangcheng, Hunan | Paddy soil | Quaternary Red clay | 5.14 | HM, SM | Double rice |
| Fengqiu, Henan | Fluvo-aquic soil | Fluvial deposits | 8.65 | HM, CH, VC, KK, SM | wheat-maize |
| Changshu, Jiangsu | Paddy soil | Lacustrine deposits | 6.65 | HM, SM, CH, VC, KK | Rice-wheat |

HM, hydromica; VC, vermiculite; KK, kaolinite; SM, smectite; CH, chlorite

# $NaBPh_4$ method

- Extraction： 0.5 g soil， addition of 3 ml 0.01M EDTA + $NaBPh_4$ solution (without NaCl)
- Block extraction： addition of 25 ml quenching solution（$NH_4Cl$ + $CuCl_2$）
- Recovery of K from $KBPh_4$： boiling for 50-55 min
- Determination of K: filtered or centrifuged for determination on a flame photometer

# Release of soil K in $NaBPh_4$ solution



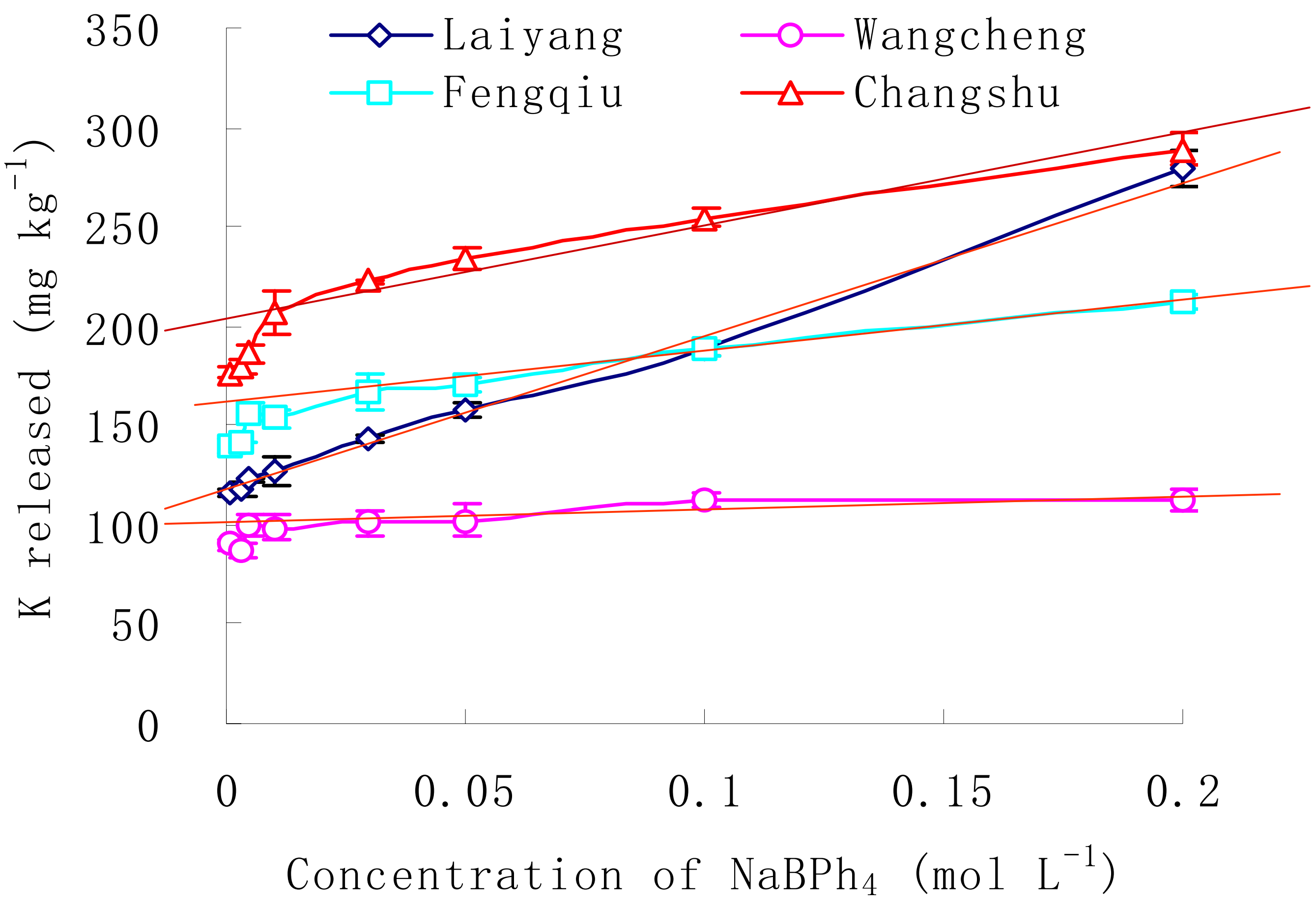

Effect of $NaBPh_4$ concentration and extraction period on the release of K from 4 soils

# Linear correlation between time and soil K released in 0.2M $NaBPh_4$ solution

| Soil | $NH_4OAc$-K mg $kg^{-1}$ | Hot $HNO_3$-K mg $kg^{-1}$ | Slope mg $kg^{-1}$ $min^{-1}$ | Intercept mg $kg^{-1}$ | $R^2$ | K released in 30 min (mg $kg^{-1}$) |
|---|---|---|---|---|---|---|
| Laiyang | 89.7 | 1068 | 2.794 | 193.3 | 0.946** | 272 |
| Wangcheng | 73.1 | 334 | 0.171 | 108.5 | 0.813** | 114 |
| Fengqiu | 126.0 | 1092 | 0.411 | 196.5 | 0.859** | 208 |
| Changshu | 149.5 | 582 | 1.351 | 252.9 | 0.976** | 293 |

Ratio of rate of K released from 4 soils: 16.4 : 1 : 2.4 : 7.9

# Release of soil K in $NaBPh_4$ solution




**The effect of concentration of $NaBPh_4$ on amount of K released from 4 soils**

# Linear correlation between concentration of $NaBPh_4$ and soil K released in 30 min

| Soil | $NH_4OAc$-K mg $kg^{-1}$ | Hot $HNO_3$-K mg $kg^{-1}$ | Slope mg $kg^{-1}$ $min^{-1}$ | Intercept mg $kg^{-1}$ | $R^2$ | K released in 30 min (mg $kg^{-1}$) |
|---|---|---|---|---|---|---|
| Laiyang | 89.7 | 1068 | 759.3 | 116.7 | 0.995** | 272 |
| Wangcheng | 73.1 | 334 | 106.8 | 95.2 | 0.667* | 114 |
| Fengqiu | 126.0 | 1092 | 336.9 | 149.3 | 0.924** | 208 |
| Changshu | 149.5 | 582 | 539.6 | 191.7 | 0.889** | 293 |

Ratio of efficiency of increased $NaBPh_4$ on the release K from 4 soils:

7.1 : 1 : 3.1 : 5.0

# Comparison of characteristics of K release from 4 soils

- Traditional $NH_4OAc$ extracted K:

  Changshu > Fengqiu > Laiyang > Wangcheng

  Traditional hot $HNO_3$ extracted K:

  Fengqiu = Laiyang > Changshu > Wangcheng

  K easily extracted by $NaBPh_4$:

  Changshu = Laiyang > Fengqiu > Wangcheng

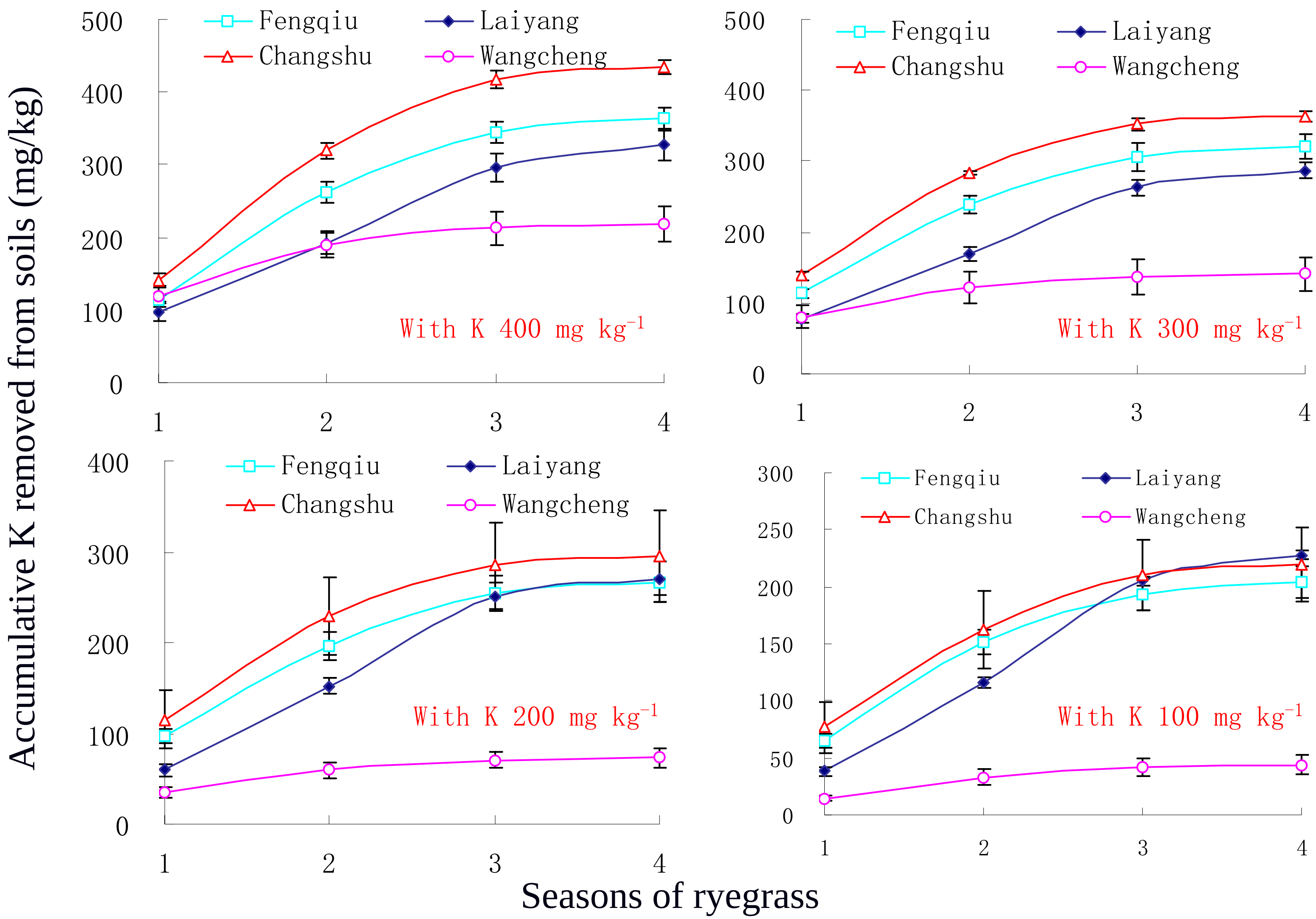
  Release rate of K easily extracted by $NaBPh_4$:

  Laiyang > Changshu > Fengqiu > Wangcheng

- Amount vs release rate of soil available K
  Which one is more important for plant K uptake?

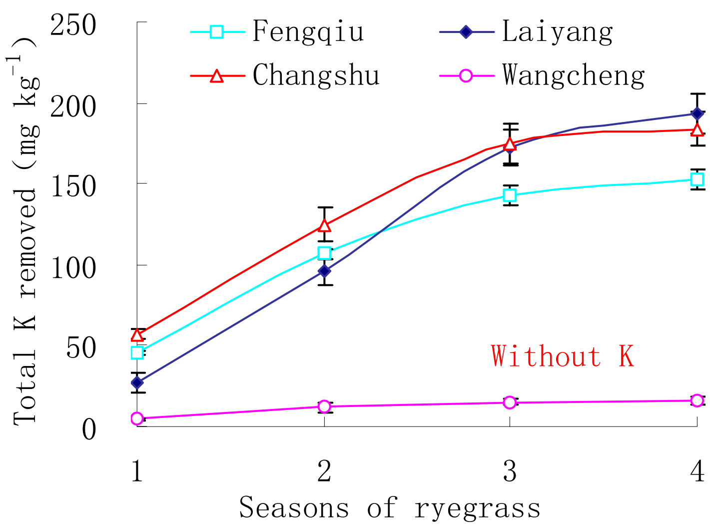
- As compared with the traditional method, is there a more suitable method for measuring soil K availability?

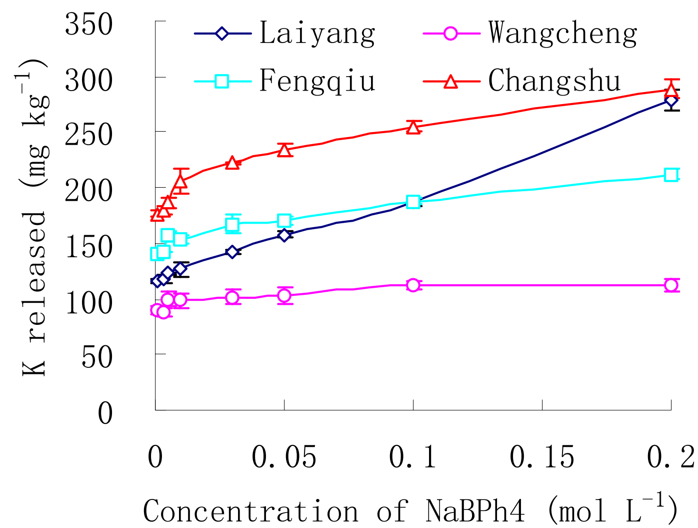
# K release from soils lead by sequential growing of ryegrass




**Effect of dose of K applied on the accumulative K removed by 4 seasons of ryegrass from 4 soils**

# K release from soils lead by sequential growing of ryegrass



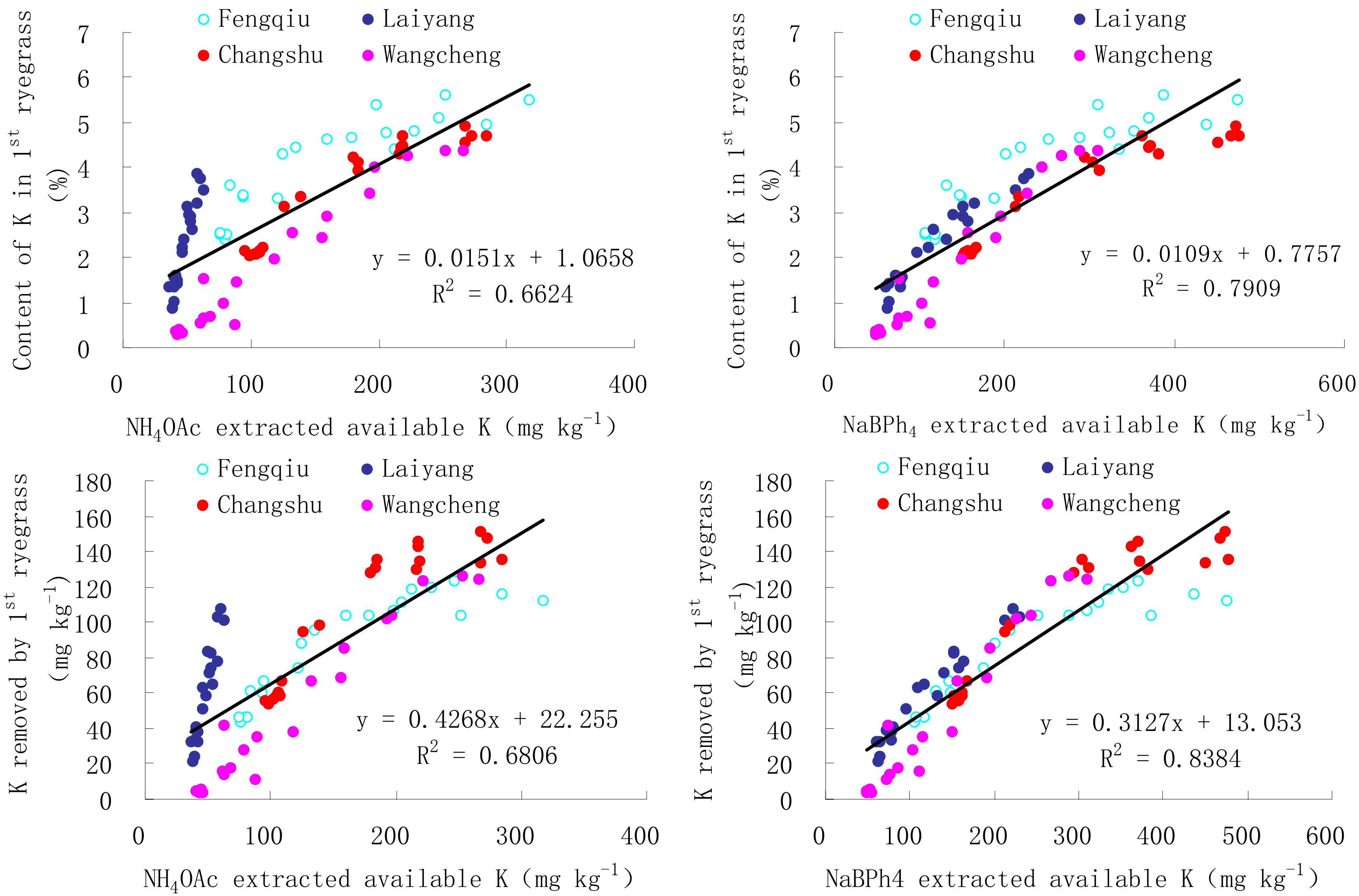

**Accumulative K removed by 4 seasons of ryegrass from 4 soils without external K**

**Amount of K released from 4 soils as affected by concentration of $NaBPh_4$**

For the soils with high level of available K (AK), the K removed by plant will not so much depend on the release rate of soil AK. For the soil with low level of AK or the soils under sequential growing of plants, the K removed by plant will largely depend on the release rate of soil AK.

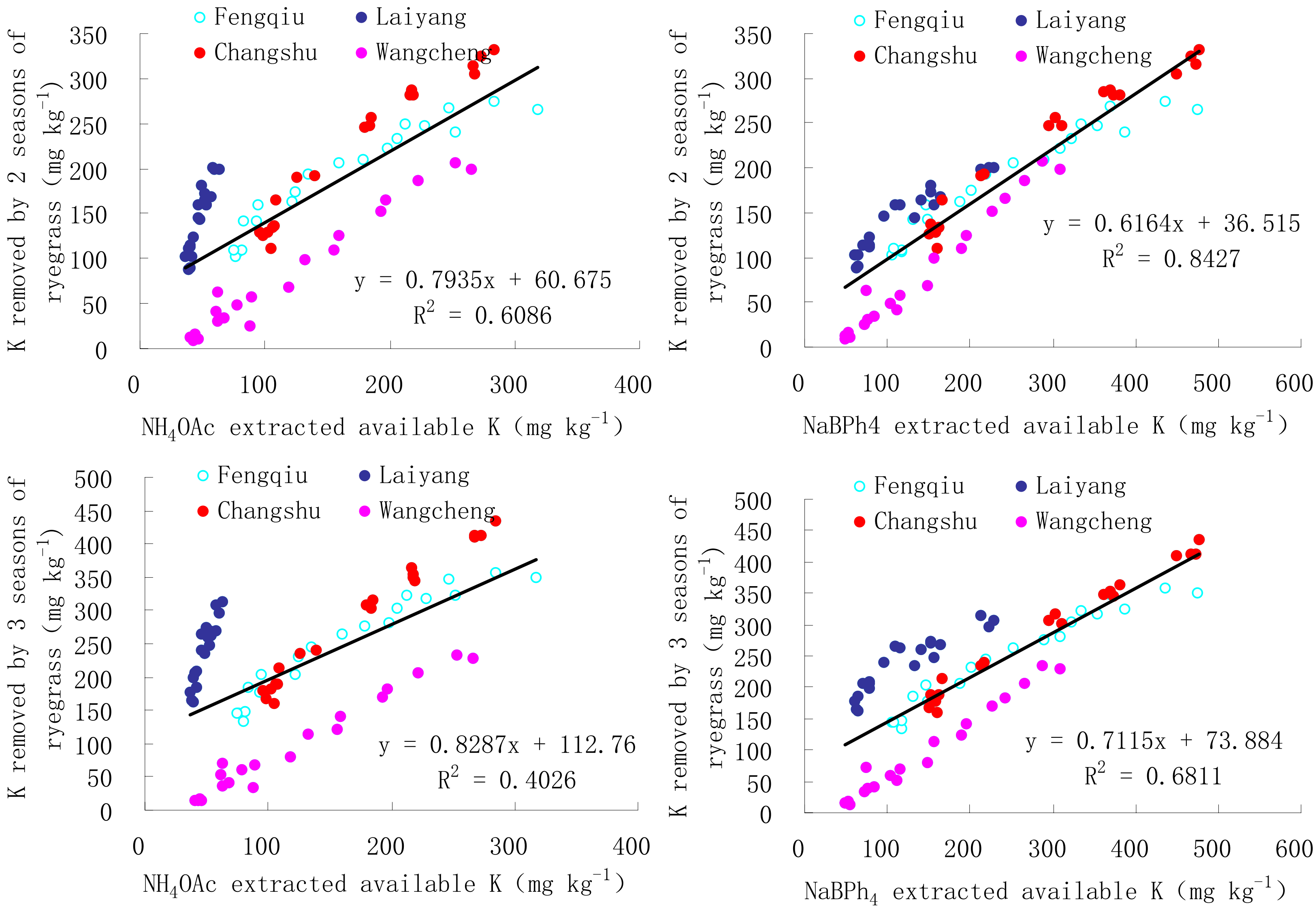
The $NaBPh_4$ method (0.2M 30min) could extract all the traditional AK together with some easily released soil K which influenced by the release rate of soil AK. Is it a good method for measuring soil AK?

# The relationship between K extracted by $NaBP_4$ and K removed by plant




**The linear correlation between K uptake, K content of ryegrass (1st season) and soil available K extracted with $NH_4OAc$ or the $NaBPh_4$ method**

# The relationship between K extracted by $NaBP_4$ and K removed by plant




**The linear correlation between accumulative K uptake by ryegrass (2 or 3 seasons) and soil available K extracted with $NH_4OAc$ or the $NaBPh_4$ method**

# Conclusion

- The amount of soil K released by $NaBPh_4$ with lowest extracting power close to the K extracted by $NH_4OAc$, more K could be released by $NaBPh_4$ as the extracting power increased. Different soils showed different K release characteristics as $NaBPh_4$ extracting power increased;
- With high level of AK in soil or the short growing period of plant, the K removed by plant will not so much depend on the release rate of soil AK. With low level of AK in soil or the long growing period of plant, the K removed by plant will largely depend on the release rate of soil AK. The soil K release pattern showed some what similar when the K was removed by plant or the $NaBPh_4$ solution;
- The results suggested that the modified $NaBPh_4$ method could be used for measuring of soil AK. The method is suitable to soils with different properties, which is much better than the traditional $NH_4OAc$ method.

# *Thanks for your attention!*