

主要作物 缺钾的诊断

DIAGNOSIS AND CORRECTION OF POTASSIUM DEFICIENCY IN MAJOR CROPS

中国科学院南京土壤研究所

国际钾肥研究所(瑞士)

北美钾肥和磷肥研究所(美国)合编

A publication produced jointly by the

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一、前言

三十多年来，中国由于复种指数的提高，优良品种的引用，氮、磷肥用量的增加以及灌溉条件的改善等，总产和单产有了很大的增长，农业生产获得了巨大的发展。

可是偏施氮肥后，使化学肥料的施用明显失去平衡。结果钾素不足正日益成为作物产量和其它肥料肥效的限制因素。

引起缺钾迅速发展的原因有：

1. 氮肥和磷肥用量的急剧增长。
2. 要求更多养分的高产品种和无性繁殖系的引入。
3. 因品种矮秆化和工业、燃料用稿秆的增长，还田的稿秆和其它有机物质减少了。

钾不足使作物产量和品质严重下降，其它肥料的肥效降低。一些推广工作者和农民已开始注意到由于作物钾素营养不足而引起的农业损失，但大多数人对缺钾还没有足够的了解。

希望这本小册子能有助于科研人员和推广工作者了解缺钾的严重情况。但必须记住的是，作物在出现可见缺钾症状之前，其产量和品质早已下降。

二、钾在植物生理和作物生产中的作用

活的植物体中进行的一切生物化学反应，差不多都有钾参加。在阳离子中，钾是植物需要量最多的。由于钾不是任何有机化合物的组成成分，它极易迁移，并且优先向幼嫩的分生组织转移。

钾虽然不是任何有机物的组成成分，但它差不多都直接或间接地参与了植物生长的每一过程。

钾的主要功能是：

1. 钾能增进根系吸水和使植物节约用水。
2. 钾能活化六十多种酶，因而在植物生长的所有主要过程中，它都直接或间接地参与了。
3. 钾可以促进能形成新有机物的光合作用的进行，并且加速光合作用产物向贮藏器官(种子、根)的输送。
4. 钾能增进蛋白质的合成，因而能提高氮肥的效应。

5. 钾能提高植物的抗逆能力。

由于钾的效果不如氮那样容易看清，因此在作物生产中，钾的下述作用常常被忽视了：

1. 要充分发挥其它肥料(特别是氮)的效益，必须要有充足的钾。

2. 钾使植物能较好地抗御干旱。

3. 钾使植物较好地改善嫌气或淹水条件下产生的不良影响。

4. 钾使植物较好地抗御霜冻。

5. 钾使植物较好地抗御多种病虫害。

6. 钾能改进水果和蔬菜的贮存品质。

7. 钾能增加作物抗倒伏的能力。

8. 对于根系的健康发育，钾是必不可少的。

9. 对一些特别注重品质的经济作物(烟草、水果和纤维作物)，钾是最重要的。

10. 对于植物体内糖的合成和转移，钾是必不可少的，因此对于甘蔗、甜菜、甘薯和其它块茎作物，钾是极重要的。

11. 钾使水果长得大。

12. 为提高豆科植物、藻类的固氮效率和生物自生固氮，钾是必不可少的。

三、导致缺钾的条件

虽然任何土壤或环境都可发生钾的不足，但常常和下述土壤、气候、管理措施有关：

A. 土壤：1. 排水不良。

2. 排水过度。

3. pH很高。

4. pH很低。

B. 气候：1. 降雨量高的地区。

2. 从湿润突然变为干旱。

3. 始终高湿度。

C. 管理：1. 其它养分，尤其是氮、钙和镁肥施用过量。

2. 从田间取走作物残体。

3. 新鲜有机肥施用过量。

四、缺钾症状

缺钾初期阶段的表现是，作物生长速度减慢，植株矮化，叶色通常发暗。进一步缺钾时，开始出现较明显的缺钾症状。由于钾是高度活性的，极易迁移，因此老叶上首先出现症状。虽然各种作物呈现的症状有差别，但植物缺钾的发展次序差不多是一样的。

下列症状随缺钾程度的增加而发展。

1. 生长速度和活力下降。
2. 叶色变暗。
3. 抗旱能力下降。
4. 通常从老叶的叶尖和叶缘开始出现带白色的，黄色的或橙色的褪绿斑点或条纹。有些品种可以出现分布不规则的褪绿斑点。但所有情况下，症状都是从叶梢开始，而叶基部常常仍保持暗绿色。
5. 褪绿区坏死，组织死亡，叶片干枯。
6. 症状蔓延到幼嫩叶片，最后整株植株可能死亡。
7. 罹病植株根系发育不良，常常腐烂。
8. 易感染病害，作物（特别是蔬菜、水果、纤维和烟草作物）品质严重下降。

除了上述“典型”症状外，钾和其它养分（尤其是氮和钙）的不平衡还可引起其它症状。

盐害、真菌侵害、药害也会引起类似于缺钾的症状，在田间进行缺钾诊断时，应予以排除。

I. INTRODUCTION

During the past three decades China has made great progress in agriculture. Crop yields have greatly increased as a result of improved irrigation, more intensive cropping and heavier use of nitrogen fertilizers.

However, the use of mineral fertilizer has been decidedly imbalanced in favour of nitrogen. As a result potassium deficiency is increasingly becoming a factor limiting crop yields and response to other fertilizer nutrients.

The rapid spread of potassium deficiency has been caused by:

- a. The sharp increase in the use of nitrogen (and phosphate) fertilizer during the last three decades.
- b. The introduction of high yielding varieties and clones that have much higher nutrient requirements.
- c. Decreased quantity of straw and other organic matter returned to the soil as a result of short, stiff-strawed varieties and the increasing use of straw for industrial purposes and as a source of feed and fuel.

A deficiency of potassium causes a severe reduction in crop yield and crop quality and reduces the effectiveness of other inputs. Most farmers and many extension workers are not yet sufficiently aware of the agricultural losses due to inadequate potassium nutrition of crops.

This booklet is designed to help research and extension workers to identify severe cases of potassium deficiency. It must be remembered, however, that crop yields and quality decline long before visual symptoms appear on the plants.

II. GENERAL REMARKS ON POTASSIUM

The role of potassium in plant physiology and crop production

Potassium is involved in almost all biochemical reactions taking place in the living plant and is the cation needed by plants in largest quantity. As it is not part of any organic compound, potassium is highly mobile and is preferentially transported to young meristematic tissue.

Major physiological functions of potassium are:

- a. Potassium enhances the uptake of water by the roots and the water economy of the plant in general.
- b. It activates more than 60 enzymes, thereby being directly or indirectly involved in all major processes of plant growth.
- c. It promotes photosynthesis, that is, the formation of new organic substances and their transport to storage organs (seeds, roots).
- d. It enhances the production of protein and thus improves the efficiency of fertilizer nitrogen.
- e. It increases the ability of plants to withstand any stress.

The roles of potassium in crop production are often underestimated because its effects are not as easily recognizable as those of nitrogen.

- a. Adequate potassium is essential to get the full benefit from other fertilizers, nitrogen in particular.
- b. Potassium makes plants more resistant to drought.
- c. Potassium makes plants more resistant to poor soil aeration or conditions of poor drainage.
- d. Potassium makes plants more resistant to frost.
- e. Potassium makes plants more resistant to many pests and diseases.
- f. Potassium improves the keeping quality of fruits and vegetables.
- g. Potassium can be important in making plants more resistant to lodging.
- h. Potassium is essential for the development of a healthy root system.
- i. Potassium is most important for crops when quality is of special concern. (Tobacco, Fruit and Fiber crops.)
- j. Potassium is essential for the formation and translocation of sugars in plants and therefore of utmost importance for crops like sugarcane, sugar beet, sweet potato and other tuber crops.
- k. Potassium favours the production of vegetable oil in crops such as oil palm, rape-seed, peanut and soya bean.
- l. Potassium increases the size of fruit.
- m. Potassium is essential for efficient nitrogen fixation by leguminous plants, algae, and free living nitrogen fixing organisms.

III. CONDITIONS LEADING TO POTASSIUM DEFICIENCY

Although potassium deficiency can occur in any soil or environment, it is often associated with the following soil, climatic, and management conditions.

- A. Soil :
 1. Excessively drained soils (sandy soils).
 2. Poorly drained soils.
 3. Very high pH soils.
 4. Very low pH soils.
- B. Climate :
 1. High rainfall.
 2. Abrupt changes from wet to dry conditions.
 3. Constant high humidity.
- C. Management :
 1. Unbalanced (excessive) use of other nutrients, N, Ca and Mg in particular.
 2. Removal of crop residues from the field.
 3. Incorporation of excessive amounts of fresh organic matter into the soil.

IV. SYMPTOMS OF POTASSIUM DEFICIENCY

First signs of potassium deficiency are a reduction in growth rates. Plants become stunted and usually leaf colour is darker. At a more advanced stage clearer deficiency symptoms start to appear. As potassium is highly

mobile, the first symptoms show on older leaves. The sequence in the development of deficiency symptoms is almost the same with all plants, although different plants may exhibit rather different symptoms.

With increasing K-deficiency the following symptoms develop:

- a. Reduction in growth rate and vigour.
- b. Darkening of the leaves.
- c. Decreased drought resistance.
- d. Appearance of white, yellow, or orange chlorotic spots or stripes on older leaves, usually starting from the leaf tips and margins. In some species irregularly distributed chlorotic spots appear, but in all cases symptoms start from the distal part of the leaf. The base of the leaf usually remains dark green.
- e. The chlorotic areas become necrotic. The tissue dies and leaves dry up.
- f. The symptoms spread to younger leaves and finally the plants can die.
- g. Roots of K-deficient plants are poorly developed and are often affected by rot.
- h. Disease incidence is increased and crop quality is severely reduced, especially in the case of vegetables, fruit, fibre and tobacco crops.

Apart from the above "typical" symptoms, other symptoms may occur as a result of imbalance of potassium with other nutrients, nitrogen and calcium in particular.

Symptoms similar to potassium deficiency can occur due to salt injury, fungus attack, spray damage, etc. When diagnosing potassium deficiency in the field, the above conditions should be checked and eliminated as possible causes of the apparent deficiency symptom.

水稻缺钾 (Rice)

目前在中国南方地区，水稻缺钾是一个较普遍的问题。集约种植、复种、高产品种(特别是杂交稻的种植)以及偏施氮肥是近年来缺钾增多的主要原因。

POTASSIUM DEFICIENCY IN RICE

Potassium deficiency in rice is now a widespread problem in many parts of China. Intensive multiple cropping, use of high yielding varieties, especially of hybrid rice, and intensive use of nitrogen fertilizer have been the main factors that have accentuated potassium deficiency in recent years.

水稻缺钾的纠正

早稻：最后一次整地前，每公顷撒施100—150公斤(13.3—20斤/亩)钾肥。

晚稻：钾肥施用与早稻一样，也可以在插秧后，第一次耘田前施用。

CORRECTION OF POTASSIUM DEFICIENCY IN RICE

Early rice: broadcast 100–150 kg of potash fertilizer per ha. (13.3–20 jin/mou) before the last land preparations.

Late rice: same as with early rice. But with late rice the potash can also be applied after planting, before the first weeding.



图片 1 (Picture No. 1)

最早的缺钾迹象是植株矮化，颜色较正常植株为暗绿。在田间通常生长不正齐。缺钾植株根系氧化力下降。右边的缺钾植株有许多黑色的烂根，相反，左边有充足钾素供应的健康植株的根呈棕褐色。

First signs of potassium deficiency are stunted plants which are darker green than normal. The stand in the field is usually irregular. Roots of K-deficient plants have a decreased oxidizing power. Note the healthy brown colour of the roots on the left side (adequate K) as against the dark colour (many rotten roots) of the K-deficient plant.



图片 2 (Picture No. 2)

缺钾加速了老叶的衰老，老叶的死亡率高。

Senescence of older leaves is accelerated by potassium deficiency and there is a high rate of mortality among older leaves.



图片 3 (Picture No. 3)

缺钾水稻成熟很不正齐，空瘪率高，谷粒品质也差。

Ripening of potassium deficient rice is very uneven and the percentage of empty grains is high. Grain quality is also poor.



图片 4 (Picture No. 4)

持续偏施氮磷肥，会导致严重缺钾。本图表明了前面无钾处理(120—60—0)和后面施钾处理(120—60—60)之间水稻生长活力和颜色上的差异。

Continued predominant use of nitrogen and phosphorus has resulted in severe potassium deficiency as shown in this picture from Indonesia. Note difference in growth, vigour and plant colour between the no-K plot (120-60-0) in the foreground as against the plot that received potassium (120-60-60).

小麦缺钾 (Wheat)

缺钾小麦植株矮化，干旱季节表现为枯萎。

老叶叶尖发生褪绿，继而坏死。褪绿区逐步向叶基部扩展。由于沿叶缘褪绿区向下移动比沿中脉快，结果中脉附近叶组织保持的绿色呈“箭头”状。

缺钾小麦茎秆细弱，较易遭受霜冻、干旱和病害。小麦缺钾时，氮肥的效用也不能充分发挥出来。

POTASSIUM DEFICIENCY IN WHEAT

Potassium deficient wheat plants are stunted and appear wilted during dry weather.

Older leaves develop chlorotic tips followed by a necrosis. The chlorotic area gradually moves downward on the leaf. As the chlorosis moves faster on the leaf margin than near the midrib, an “arrow” of green tissue is left around the midrib.

The culms of potassium deficient wheat are thin and weak. Potassium deficient wheat therefore cannot respond well to nitrogen application. Potassium deficient wheat is also more susceptible to frost, drought and diseases.

小麦缺钾的纠正

于耕翻前将钾肥撒施在茬上，每公顷 75—150 公斤 (10—20 斤/亩)。也可在耕翻后，最后一次耙地前施用。

CORRECTION OF POTASSIUM DEFICIENCY IN WHEAT

Broadcast 75–150 kg of potash fertilizer per ha. (10–20 jin/mou) on the stubble before ploughing. Potassium can also be applied after ploughing, before the last harrowing.



图片 5 (Picture No. 5)

这是开花期的缺钾小麦。剑叶叶尖发黄。麦穗不饱满，籽粒特别是穗尖部分发育差。

Potassium deficient wheat at flowering. Note the yellowing of the tip of the flag leaf. K-deficient wheat will have poorly filled ears, especially at the top.