

# POTASH FACTS IN BRIEF



*POTASSIUM. AN ESSENTIAL NUTRIENT*



INTERNATIONAL POTASH INSTITUTE  
COORDINATION INDIA



POTASH RESEARCH INSTITUTE OF INDIA

**IPI** web site: [www.ipipotash.org](http://www.ipipotash.org)

# POTASSIUM

## AN ESSENTIAL NUTRIENT

### WHAT IS POTASSIUM ?

- **Potassium** is one of the essential nutrients for plant growth and vital for sustaining modern high-yield agriculture.
- Plants need large quantities of **potassium**, as much as, or even more than nitrogen. **Potassium** is vital for all crops.
- **Potassium** not only improves yields, but also crop quality. Hence, **potassium** fertilization results in a higher value product and therefore in a greater return to the farmer.



① **K** application increases number of spikes and grains in wheat

Jiajiang, Sichuan, China, 1999

### WHAT IS THE ROLE OF POTASSIUM IN PLANT GROWTH ?

**Potassium** plays a key role in many metabolic processes in the plant:

- **Potassium** is essential for photosynthesis,
- **Potassium** activates more than 60 enzymatic systems,
- **Potassium** promotes translocation and storage of assimilates,
- **Potassium** is required for N uptake and synthesis of protein,
- **Potassium** favors a high energy status in the plant,
- **Potassium** controls tissue water balance, for more efficient water use.



② **K** application increases potato yield and tuber size

Jalandhar, Punjab, India, 1998

## WHY CROPS RESPOND TO POTASSIUM FERTILIZATION ?

All crops (cereals, oilseeds, root and tubers, fiber crops, vegetables, sugar beet and cane, fruits, tobacco and stimulants, and pulses) take up **potassium** at considerable rates and therefore respond well to **potassium** fertilization.

**Potassium** fertilization leads to numerous positive effects on the many plant functions for which it is indispensable:

- *Potassium* increases root growth (see photo 5),
- *Potassium* improves drought tolerance (see photo 8),
- *Potassium* enhances winter hardiness and resistance to frost (see figure C),
- *Potassium* decreases the incidence of pests and diseases (see photos 9-12),
- *Potassium* reduces stalk lodging (see photo 7),
- *Potassium* increases nitrogen fixation (nodulation) of legumes (see photo 5),
- *Potassium* improves the efficiency of nitrogen utilization in the plant.



③ **MAIZE** Jiayang, Sichuan, China, 2000



④ **GROUNDNUT** Orissa, India, 1995



0 kg K<sub>2</sub>O / ha →  
Less developed root system  
Less nodules for N fixation



← 50 kg K<sub>2</sub>O / ha  
More developed root system  
More nodules for N fixation

⑤ **SOYBEAN**

Sehore, M.P., India, 1999

## HOW DOES POTASSIUM INCREASE QUALITY OF CROPS ?

**Potassium** is referred to as the *quality element* in crop production. Adequate **potassium** nutrition improves many quality aspects of the crops:

- Potassium increases protein percentage in grains (see figure A),
- Potassium increases starch, oil and vitamin C content (see figure B),
- Potassium increases size of fruits and tubers (see photos 2 & 6),
- Potassium enhances fruit color and flavor,
- Potassium improves storage and shipping quality of agricultural products,
- Potassium extends shelf life of agricultural products.

### CITRUS: Bigger oranges with K

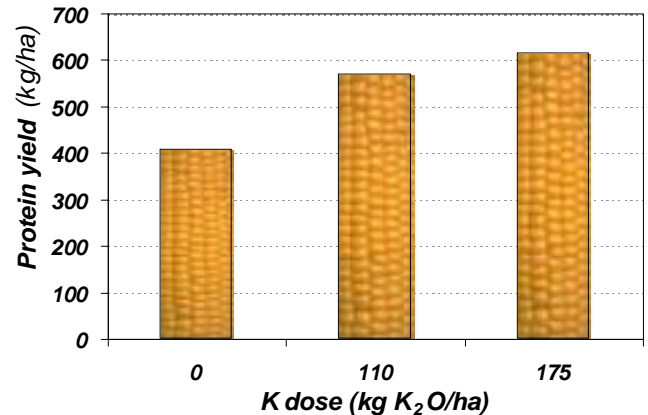


6

A.R.O., Bet Dagan, Israel, 1995

### MAIZE: Higher protein yield in grains with K

(protein yield = grain yield \* % protein)

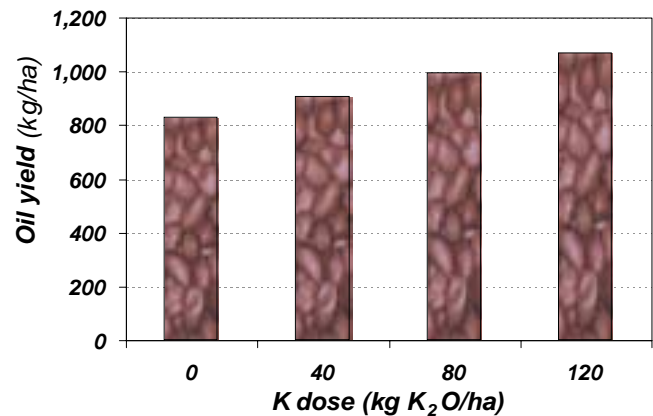


A

Jiajiang, Sichuan, China, 1999

### GROUNDNUT: Higher oil yield in seeds with K

(oil yield = pod yield \* % oil)



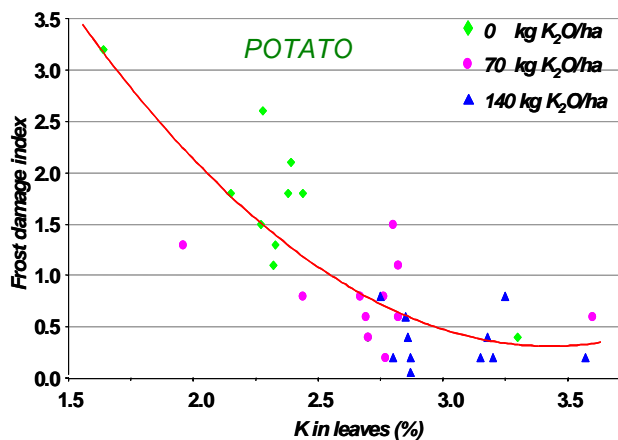
B

Junagadh, Gujarat, India, 1998

## How does POTASSIUM HELP CROPS TO TOLERATE STRESS ?

**Potassium** regulates plant metabolism and promotes vigorous growth. This ensures a healthy and sturdy crop which is more resistant to different stresses:

- **Drought:** *potassium* regulates plant transpiration by controlling stomatal opening, thus maintaining turgor, and reducing water loss and wilting (see photo 8),
- **Frost:** *potassium* promotes growth of large xylem vessels and high content of sugars and reserve carbohydrates in the cell, resulting in improved frost hardiness (see figure C),
- **Lodging:** *potassium* builds cellulose and counteracts the effects of excessive nitrogen, making stalks stronger and thicker (see photo 7).



© Redrawn from data in: Grewal and Singh, 1980  
*Plant and Soil* 57: 105-110

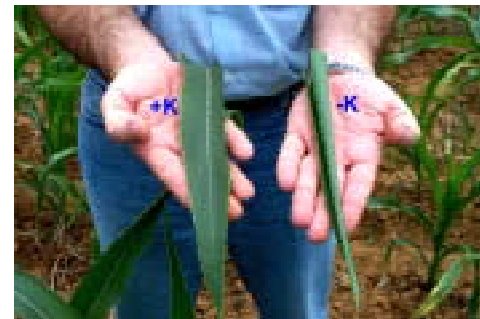
### K and lodging of wheat



Gurdaspur, Punjab, India, 1997

7

### K and drought in maize



Jiajiang, Sinchuan, China, 2000

8

Frost damage decreases as potassium content in leaves increases

## How DOES **POTASSIUM** HELP CROPS TO RESIST DISEASES AND PEST ATTACKS ?

**Potassium** enhances plant growth, ensuring a healthy crop, free from stresses and much more resistant to attack from pests and diseases. Adequate **potassium** nutrition provides:

- Thicker cell walls,
- Stronger stems and stalks,
- No sugar accumulation in the leaves,
- No accumulation of unused nitrogen.

Therefore, the beneficial effects of **potassium** are:

- For diseases: plants are more resistant to entry and infection by fungi, bacteria and viruses,
- For pests: plants become less palatable to insects.

### **K** and diseases

#### **POTATO**



LATE BLIGHT Jalandhar, Punjab, India, 1998

#### **WHEAT**



RUSTY SPOTS Anhui, China, 1999

### **K** and insects

#### **SOYBEAN**



Amlaha, M.P., India, 1999

#### **MAIZE**



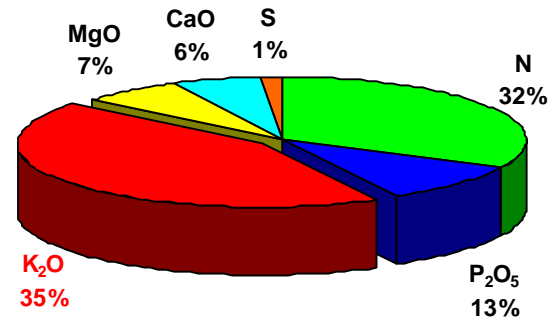
Jiajiang, Sichuan, China, 2000

## HOW MUCH POTASSIUM DO CROPS REMOVE FROM THE SOIL ?

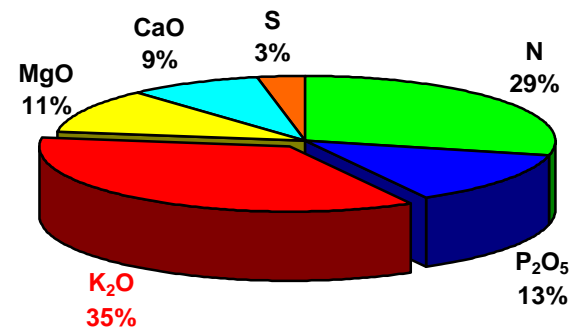
- Harvest of crops “harvests” nutrients from soil,
- The removal figures clearly show that plants need large quantities of **potassium**, and take up as much as, or even more **potassium** than nitrogen,
- An average crop of rice yielding 5 t/ha removes 110 kg N/ha, 34 kg P<sub>2</sub>O<sub>5</sub>/ha and 156 kg K<sub>2</sub>O/ha. The higher the yield, the higher the removal of nutrients,
- More **potassium** is removed by most crops than any other nutrient, indicating the necessity of applying an adequate quantity of **potassium**.

### REMOVAL OF PLANT NUTRIENTS BY CROPS

Crop	Yield	Nutrient removal , kg/ha		
	Mt/ha	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Maize	6	120	50	120
Wheat	6	170	75	175
Potato	40	175	80	310
Tomato	50	140	65	190
Soybean	3	220	40	170
Sunflower	3	120	60	240
Citrus	30	270	60	350
Cotton (lint)	1	120	45	90
Sugarcane	100	130	90	340



Nutrients removal by RICE yielding 5 t/ha



Nutrients removal by MAIZE yielding 9.5 t/ha

## HOW CAN WE RECOGNIZE POTASSIUM DEFICIENCY IN CROPS ?

Crops growing without sufficient **potassium** shortage show clear visual indications of **potassium** stress or hunger:

- Older leaves are always affected first, exhibiting white, yellow or orange spots or stripes, starting from the leaf tips and margins,
- The chlorotic areas in the leaves become necrotic, and leaves have a scorched appearance. The tissue turns brown and dies, and leaves dry up,
- The symptoms spread to younger leaves, which are smaller and dark green-bluish colored,
- Stalks are thin and fragile, and may collapse (*lodging*),
- Roots are poorly developed and often affected by rot,
- Disease incidence is increased,
- Fruits remain small and dull in color.

### **K** deficiency symptoms

#### IN RICE



Pantnagar, U.P., India, 1996

#### IN COTTON



Karnataka, India, 1996

#### IN CITRUS



A.R.O., Bet Dagan, Israel, 1997



## WHEN CROPS SHOW NO DEFICIENCY

### SYMPTOMS, WHY SHOULD POTASH BE APPLIED ?

- Once deficiency symptoms appear, crops have already suffered vast damage. Plants suffer from **potassium** hunger for a long time without visual symptoms. This is called “hidden hunger”, and results in lower crop yield and quality.
- Therefore one should not wait for **potassium** deficiency symptoms to appear, it will already be too late !



*K application in paddy rice, China*

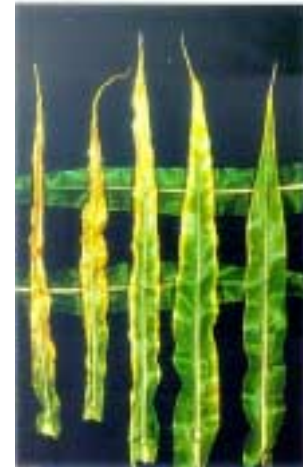
### **K** deficiency symptoms

#### IN POTATO



*Jalandhar, Punjab, India, 1998*

#### IN MAIZE



*Israel, 1974*



## FERTILIZATION WITH POTASSIUM

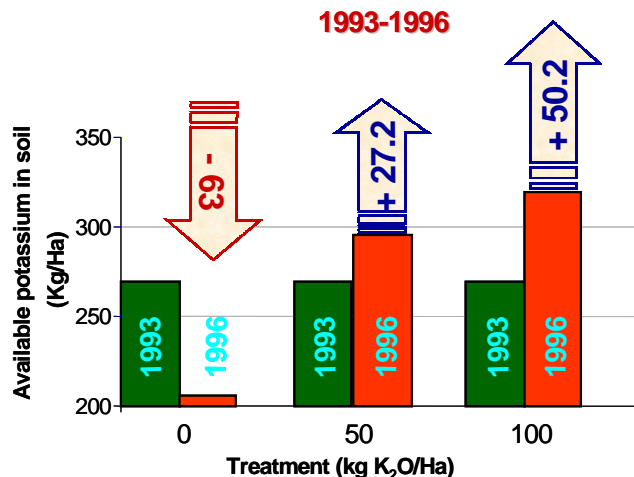
**POTASSIUM FERTILIZATION IS ESSENTIAL TO MAINTAIN SOIL PRODUCTIVITY AND FERTILITY**

The farming of soils for decades, crop after crop, and more recently with the intensive use of high-yielding seeds and modern agrotechnologies, has depleted soils of their **potassium** content.

Successive harvests remove large quantities of **potassium** from the soil and if **potassium** is not sufficiently replaced by fertilization, soils become deficient in **potassium**.

**Without potassium fertilization it is not possible to sustain high yields**

**K balance in soil after 3 years of wheat-soybean rotation**



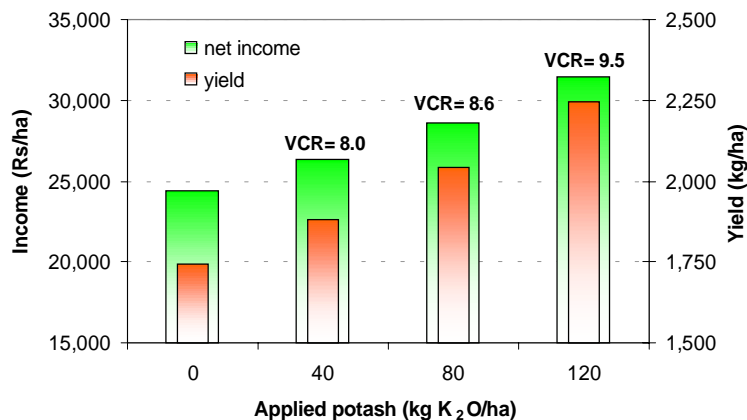
Amlaha, M.P., India, 1996

## HIGHER PROFITS WITH POTASSIUM FERTILIZATION

Higher yields, better quality, more profits – these are the benefits of **potassium** to the farmer.

For example, groundnuts in India:

- **Potash** application increased groundnut yields by 30%,
- Although the farmer spent 740 rupees (~US\$18) to apply 120 kg K<sub>2</sub>O/ha of **potash**, he earned an extra of 7,069 rupees (~US\$177) with higher yields,
- The VCR (value cost ratio) shows that each rupee invested in **potash** returned more than 8 rupees.



1 \$ = 42 Rs.

Junagadh, Gujarat, India, 1997

## POTASH FERTILIZERS

Fertilizer	Formula	% K <sub>2</sub> O	Common term
Potassium Chloride	KCl	60	Muriate of Potash - MOP
Potassium Sulfate	K <sub>2</sub> SO <sub>4</sub>	50	SOP
Potassium Nitrate	KNO <sub>3</sub>	46	NOP
Monopotassium Phosphate	KH <sub>2</sub> PO <sub>4</sub>	34	MKP

## WHAT HAPPENS TO THE POTASH IN THE SOIL ?

- When **potash** is applied to the soil, it is exposed to soil moisture and breaks down in cation (K<sup>+</sup>) and anion (Cl<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, H<sub>2</sub>PO<sub>4</sub><sup>-</sup>),
- The K in the soil water is taken up by the roots of the growing crop,
- The K from fertilizer behaves the same as any other soil K.



## WHITE OR RED MOP ?

- As long as the **MOP** contains the correct chemical and nutrient content, crops do not distinguish between white and red **MOP**.



Red MOP



White MOP



Pink MOP



For Fertilization

When it comes to Potash, crops are **COLOr**-blind

## POTASH GRADES

**Potash** is produced in different grades for various uses and application methods:

- Granular grade:** For bulk blending and direct application,
- Standard grade:** For direct application and NPK granulation,
- Fine grade:** For NPK granulation, liquid solutions and SOP production (from MOP),
- Soluble grade (white):** For application through irrigation systems (fertigation)



White Potash  
for fertigation



## POTASSIUM CONVERSION FACTORS

Given	Wanted	Multiply by:
K	K <sub>2</sub> O	1.20
K <sub>2</sub> O	K	0.83
KCl	K <sub>2</sub> O	0.60
K <sub>2</sub> O	KCl	1.67
K <sub>2</sub> SO <sub>4</sub>	K <sub>2</sub> O	0.50
K <sub>2</sub> O	K <sub>2</sub> SO <sub>4</sub>	2.00
KNO <sub>3</sub>	K <sub>2</sub> O	0.46
K <sub>2</sub> O	KNO <sub>3</sub>	2.17

## EXAMPLE: COMPOSITION OF MOP FERTILIZER



(\*) mainly MgCl<sub>2</sub>, CaCl<sub>2</sub> and NaCl

Prepared by:

Patricia Imas and Hillel Magen

### INTERNATIONAL POTASH INSTITUTE

#### IPI COORDINATION INDIA



c/o DSW, Potash House, P.O.B. 75  
Beer-Sheva, 84100, Israel  
Tel.: +972-7-6465129  
Fax: +972-7-6280995  
E-mail: patricia@dsw.co.il

#### IPI HEAD OFFICE

P.O. Box 1609  
Basel, CH-4001, Switzerland  
Tel.: +41-61-2612922  
Fax: +41-61-2612925  
E-mail: ipi@iprolink.ch

### POTASH RESEARCH INSTITUTE OF INDIA

Sector 19, Gurgaon  
Haryana, 122 001, India  
Tel.: +91-124-6340185  
Fax: +91-124-6341792  
E-mail: priiin@bol.net.in



December 2000

All rights reserved by IPI