砂漠に生きる野生植物：有用遺伝子資源の探索と利用

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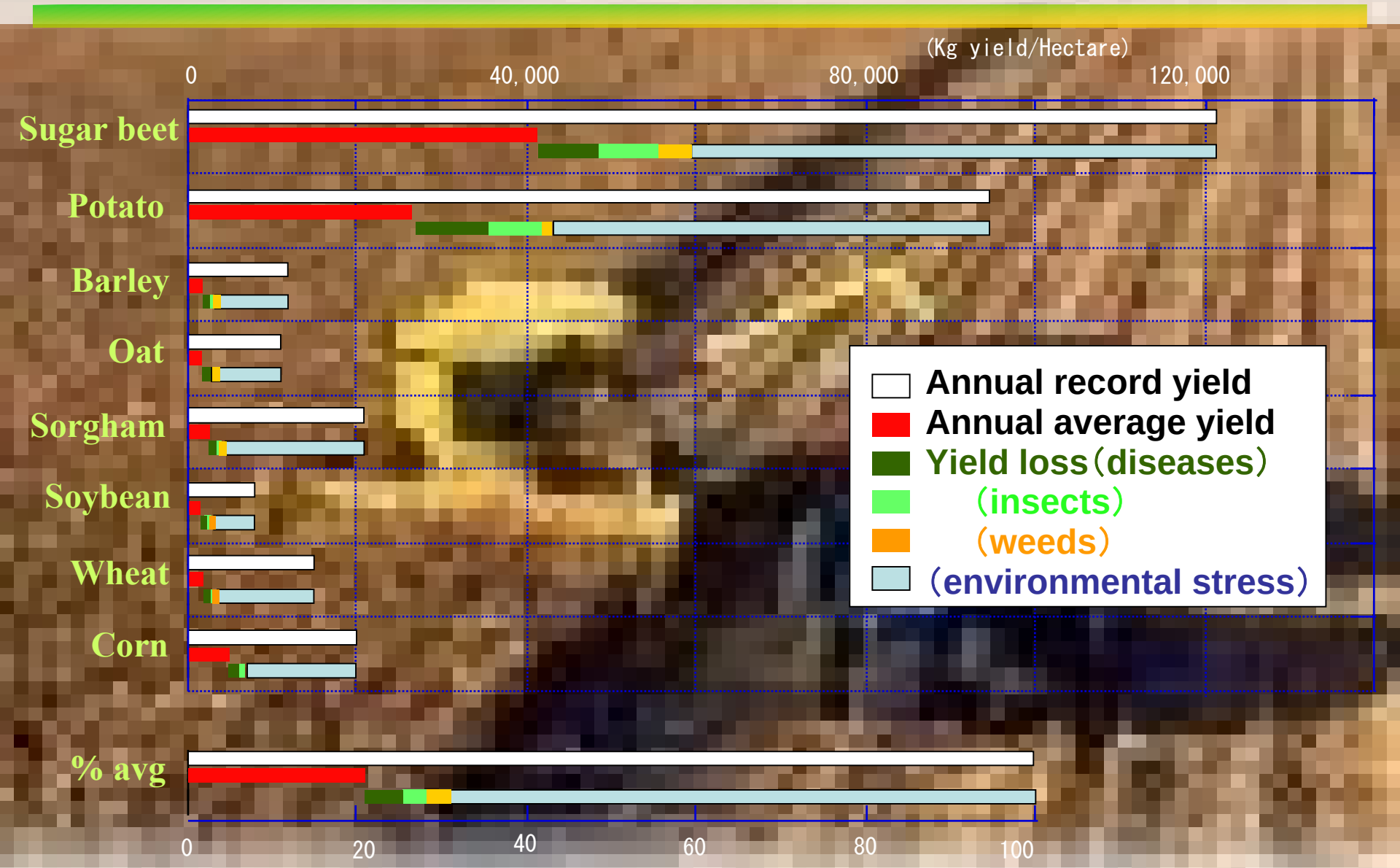
Annual record yield, average yield, and yield losses due to diseases, insects and unfavorable physicochemical environments for major U.S. crops



Boyer (1982) Science 218, 443-448

Survival strategies of xerophytes under water deficits

Plants

- Hydrophyte

- Mesophyte — Adapts to humid condition

- Xerophyte
  - **Drought escape**
    - Short life cycle
    - Developmental plasticity
  - **Drought resistant**

Excess light
High temperature
stresses

- **Drought avoidance**

Wild watermelon

  - Efficient water uptake
  - Prevention of water loss
  - Water storage
- **Desiccation tolerance**

Craterostigma
Resurrection plant

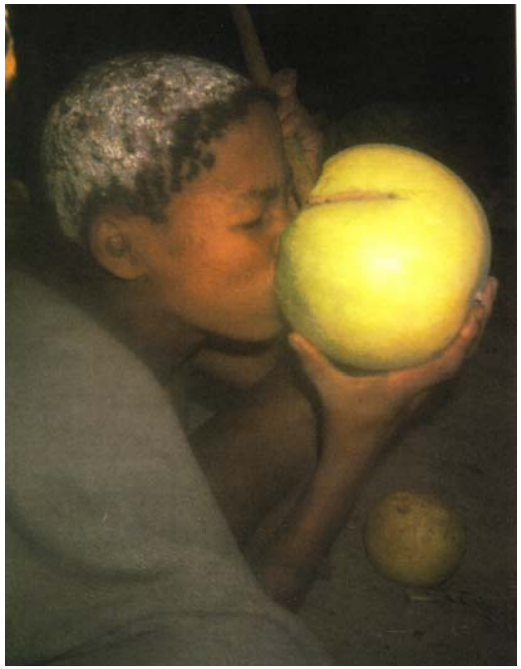
  - Vitrification
  - Efficient cellular repair and recovery

Wild Watermelon

- ★ Inhabit in the Kalahari Desert, Africa.
- ★ Thrives in the spring to summer.
- ★ Highly tolerant to drought and high light stresses.
- ★ Carries out C3-type photosynthesis.

Kalahari Desert (Botswana)

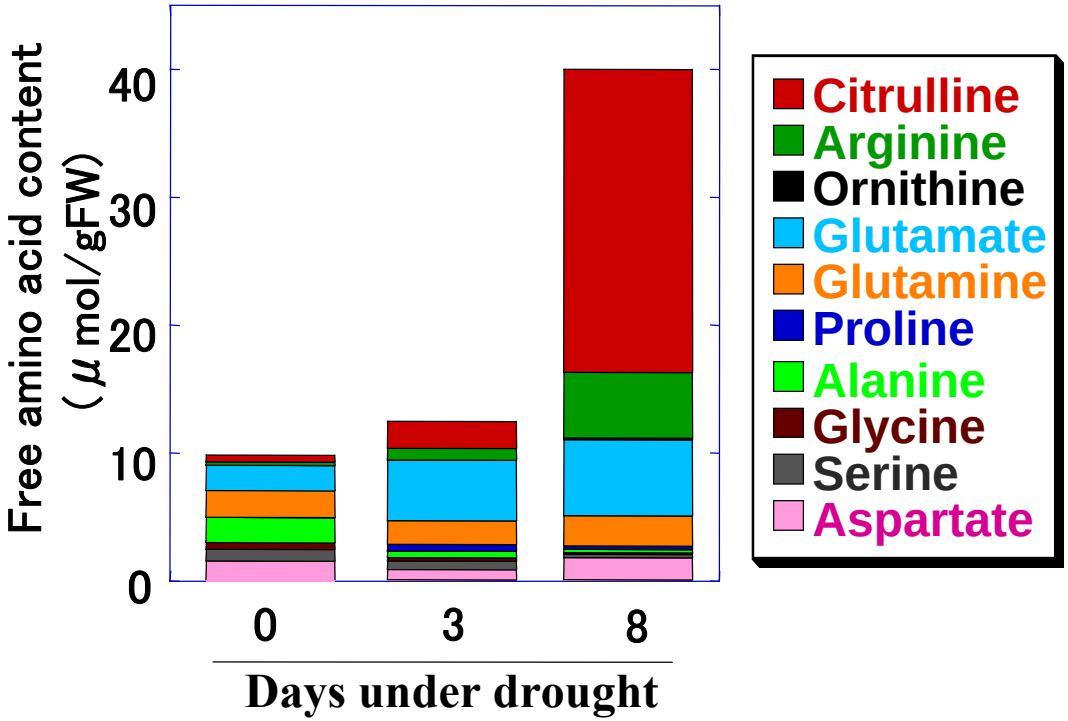
Wild watermelon and “Sun” people in Kalahari Desert

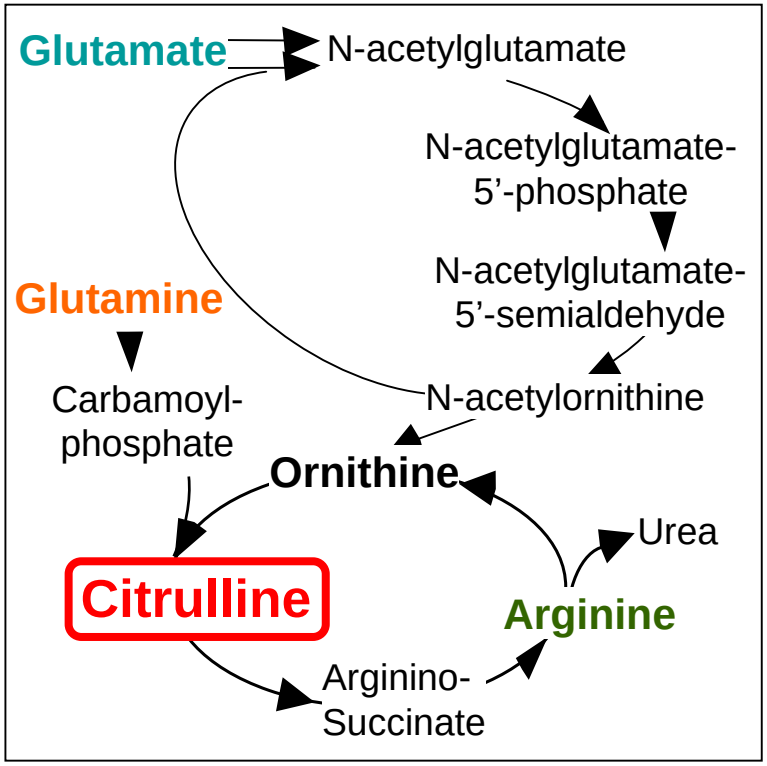


“Sun people” lives in the Kalahari Desert, Africa. They use fruit extracts of wild watermelon as major water resources for their living, such as drinking, cooking, and washing their bodies.

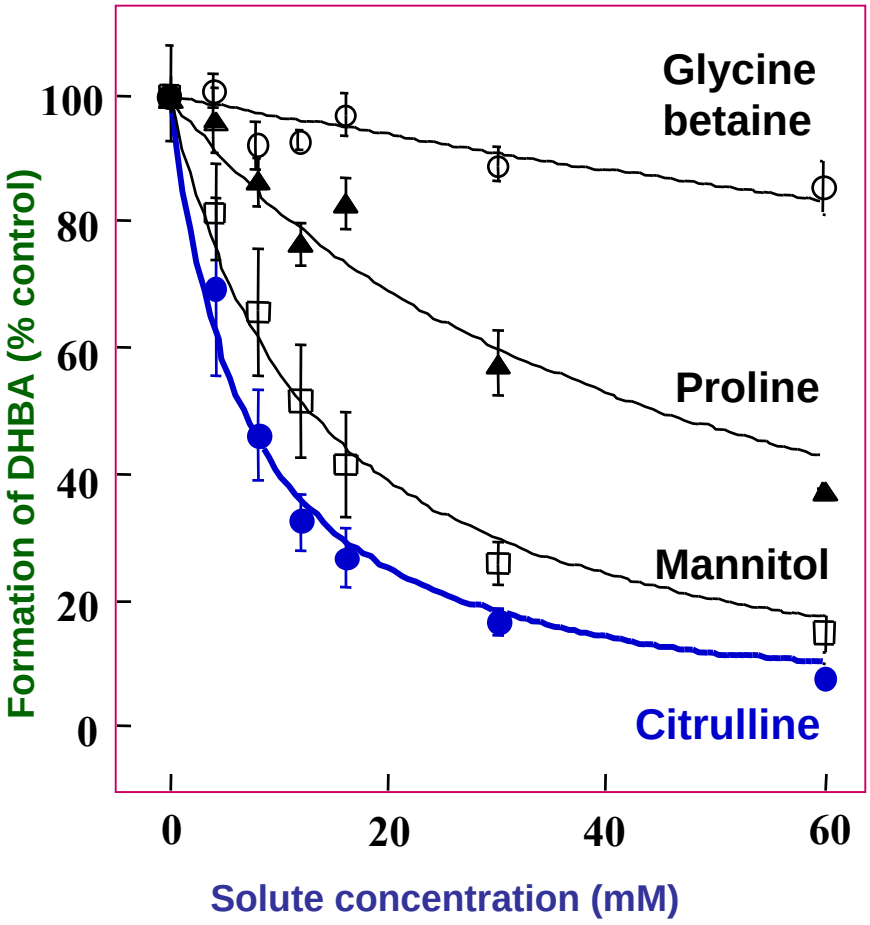
Ikeya (1991) Kikan-minzokugaku、56:35-42

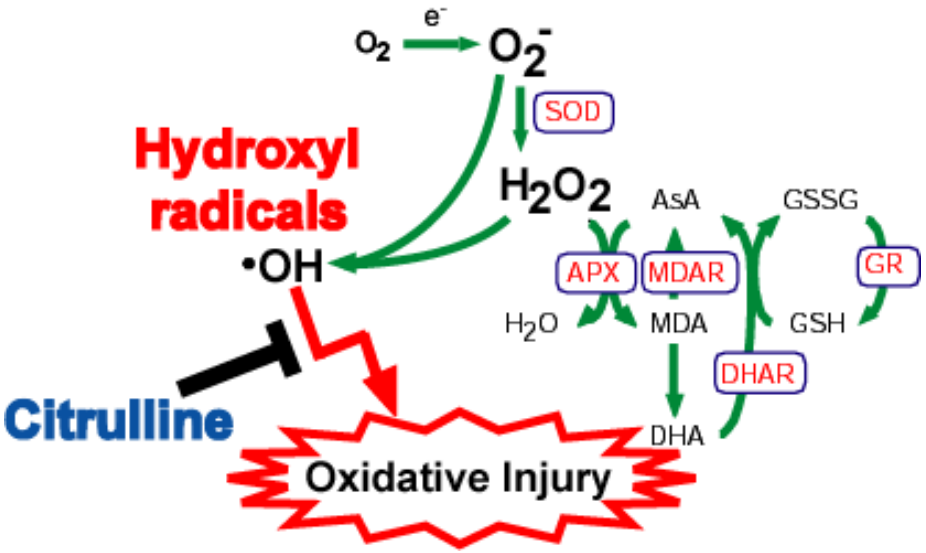
Drought-induced accumulation of citrulline in the leaves of wild watermelon





Citrulline is a potent scavenger for hydroxyl radicals



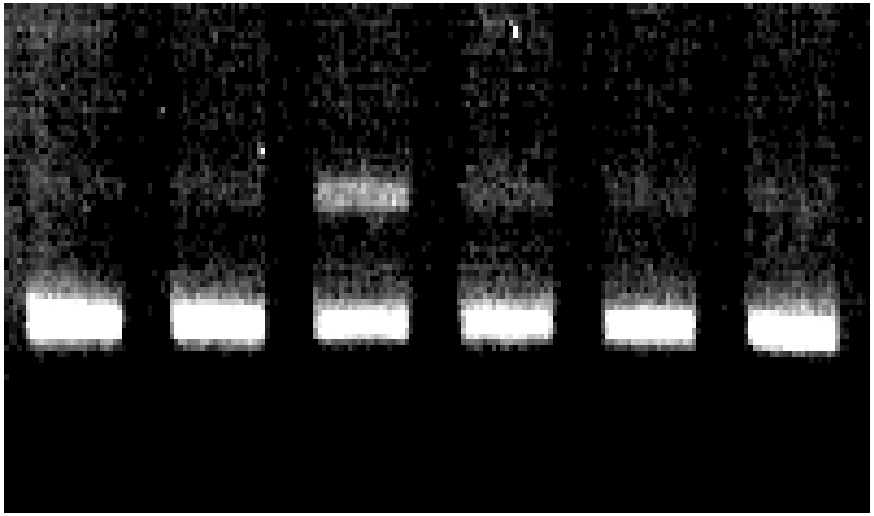


Second-order rate constants for the reactions between hydroxyl radicals and various compounds

Compound	Rate constant (M^{-1} s^{-1})	Concentration *in vivo* (mM)	Half-life of hydroxyl radicals generated *in vivo* (ns)
Citrulline	3.9×10^9	200 - 300	0.59 - 0.89
Mannitol	2.1×10^9	100 - 320	1.0 - 3.3
Proline	5.4×10^8	120 - 428	3.0 - 11
Glycine betaine	8.2×10^7	320 - 1,000	8.5 - 26
Ascorbic acid	7.3×10^9	25 - 50	1.9 - 3.8
Glutathione	8.6×10^9	1 - 4.5	18 - 80

Citrulline protects DNA from oxidative damages

H_2O	−	−	+	+	+	+
$Fe^{2}(II)$	−	+	+	+	+	+
Citrulline (mM)	0	0	0	50	100	200



Damaged DNA (linear)

Intact DNA (supercoiled)

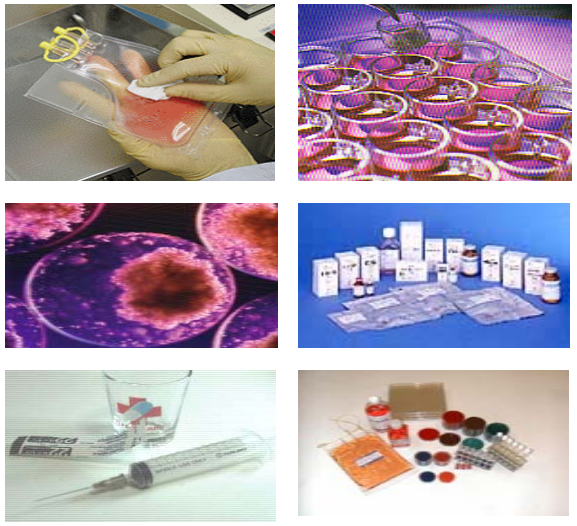
野生スイカ・シトルリン

- 天然成分
- 活性酸素ヒドロキシル・ラジカルの分解に優れる
- 高い安全性
- 光に対して安定で、持続性に優れる

化粧品

医薬品
構成成分

機能性食品・
食品添加物



スキン・ケア（しみ・そばかす・
しわ・アトピー性皮膚炎）

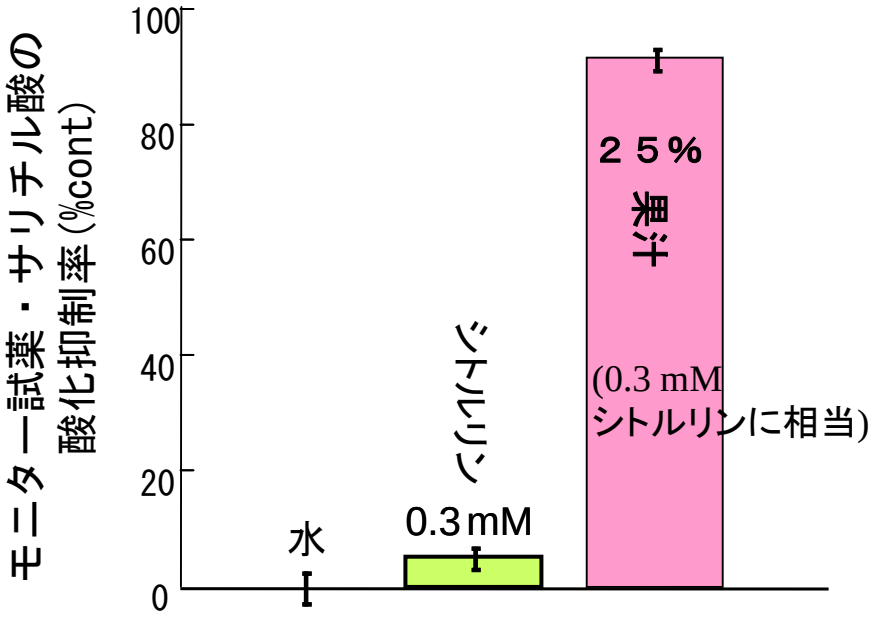
活性酸素傷害の緩和

食品の保存性の向上
体内環境の改善

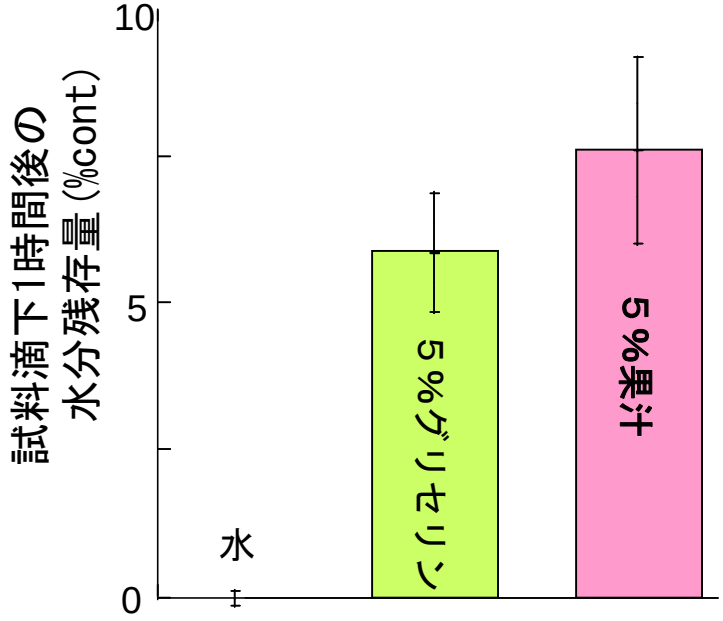
カラハリ･スイカの果実

☆ シトルリン高含量、
☆ 水溶性炭水化物が多いが、甘味料を含まず、低カロリー
☆ 抗酸化能力に極めて優れている
☆ 水分の保湿効果が高い

カラハリ･スイカの抗酸化効果



カラハリ･スイカの保湿効果



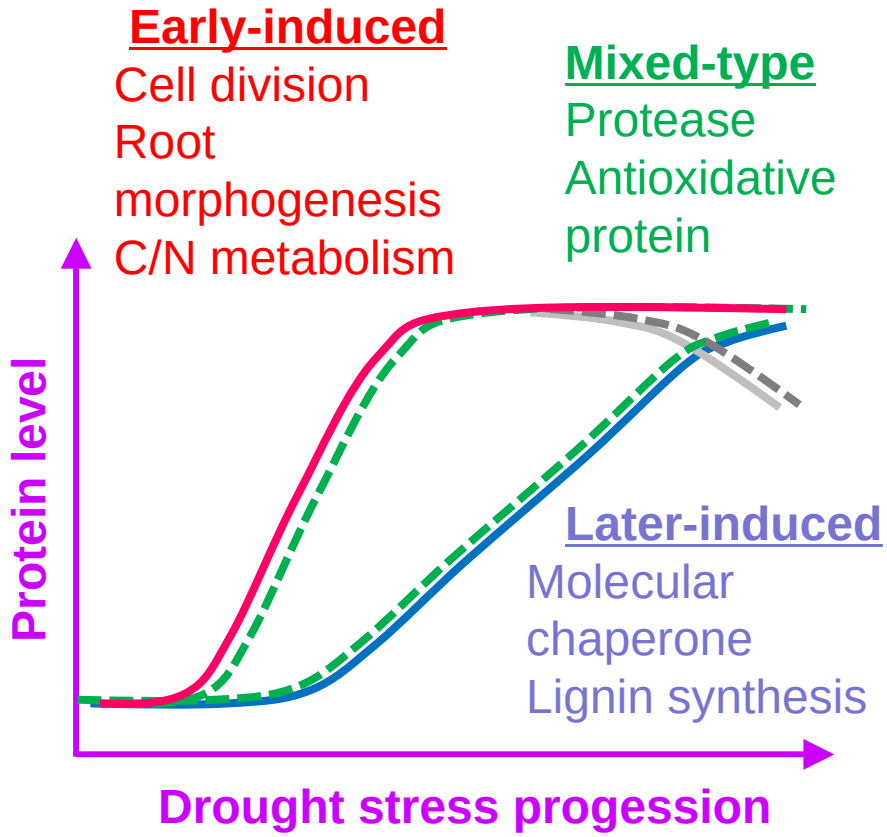
特許：特願2004-135241、野生スイカ抽出物を含有する活性酸素消去剤ならびに保湿剤

Roots of the Desert Plants

Wickens (1998)

Drought-induced proteins in the roots

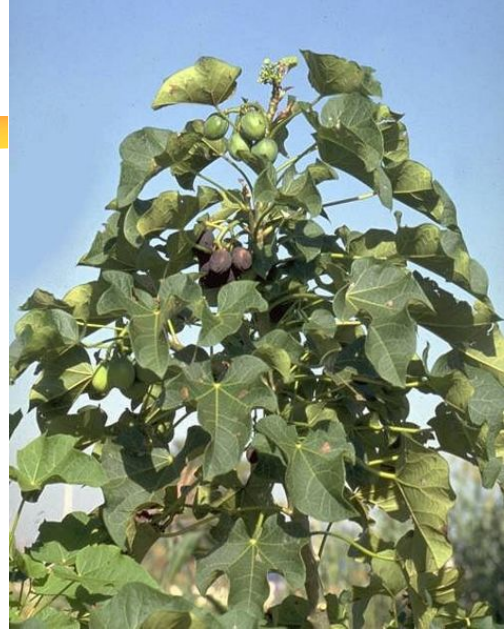
No.	Fold increase 1 day	3 days	Annotation
IE01	1.7	1.4	**aconitase**
IE03	2.3	0.9	**alkaline α galactosidase 2**
IE04	1.6	1.6	**methionine synthase**
IE05	1.6	2.7	**α-mannosidase**
IE08	4.8	1.3	**UDP-sugar pyrophospharylase**
IE09	1.3	1.1	**NADP-malic enzyme**
IE10	2.3	0.9	**NADP-malic enzyme**
IE13	34.6	11.6	**cytosolic phosphoglucomutase**
IE14	3.7	4.4	**T-complex protein 1, ETA subunit**
IE17	1.4	0.5	**Hsp 90**
IE21	2.3	1.0	**ferric leghemoglobin reductase**
IE22	2.0	1.6	**UDP-glucose 6-dehydrogenase**
IE24	2.3	1.0	**hypothetical protein**
IE38	2.7	4.5	**ubiquitin family protein**
IE40	14.8	0.9	**glutamine synthetase**
IE42	1.2	1.6	**peroxidase**
IE43	2.5	3.8	**peroxidase**
IE46	1.8	1.5	**actin**
IE50	26.8	2.6	**α-tubulin**
IE53	1.8	3.3	**unknown protein**
IE54	1.7	0.8	**putative elongation factor 2**
IE57	66.6	0.3	**sec13-like protein**
IE59	1.3	2.2	**cysteine protease CP1**
IE60	1.5	1.7	**caffeoyl-CoA O-methyltransferase**
IE64	1.5	1.9	**rubber elongation factor**
IE67	1.4	1.9	**cysteine protease**
IE71	2.7	5.9	**cytosolic triosephosphate isomerase**
IE77	2.0	3.2	**triose phosphate isomerase**



Yoshimura et al (2008) Plant Cell Physiol

Jatropha curcas L.

- **A member of the *Euphorbia* family**
- **Originated from Central America**
- **Relatively resistant to drought**
- **Grows well in marginal/poor soils**
- **Optimal annual temperature and precipitation: 20-28℃ and 480-2400 mm or more**
- **Grows relatively quickly, and produces high yield of seeds (~5 tons /ha/year)**
- **Seeds contain large amount of oils (30-40%)**



A CHOICE OF CROPS

Biodiesel crop	Litres of oil per hectare
Oil palm	2,400
Jatropha*	**1,300**
Rapeseed (canola)	1,100
Sunflower	690
Soya bean	400

財団法人 日産科学振興財団
NISSAN SCIENCE FOUNDATION

独立行政法人
科学技術振興機構
JST

NAIST

Genome engineering
Transgenic selection
Functional analyses

PhiT
Plant High Technology Institute

Chloroplast engineering
Processing/ Marketing

国立大学法人
琉球大学
University of the Ryukyus

Elite germline selection
Physiological analyses
Field assessment

Elite germline selection
Assessment in arid areas

Elite germline selection
Assessment in tropics

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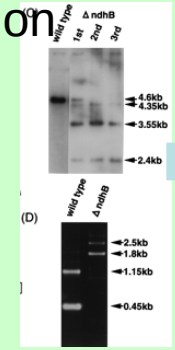
The Department of Agricultural Research
Ministry of Agriculture, Botswana

JST/NSF Jatropha PJ

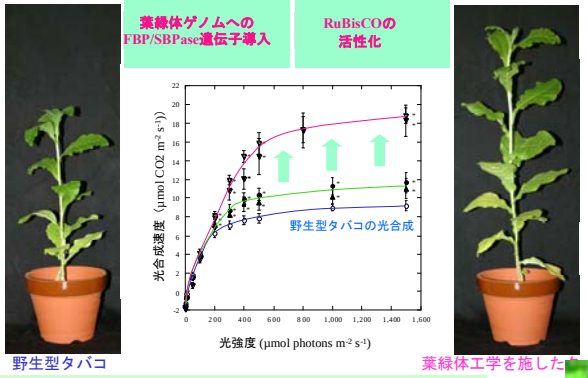
Chloroplast Transformation Technology



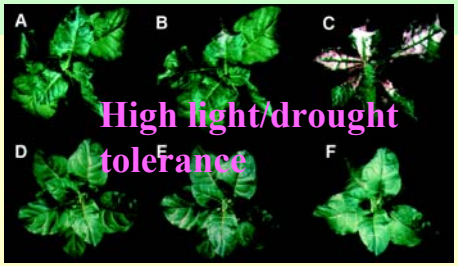
Fortification of Photosynthetic activity via gene transfer

タバコ葉緑体ゲノムへのラン藻FBP/SBPase遺伝子導入による光合成と生産性の向上

学会発表：３月末の農芸化学会大会
出願番号：特願２００４?５９５１３
出願日：平成１６年３月３日



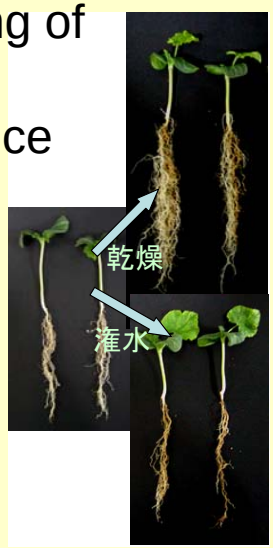
Optimization of cultivation



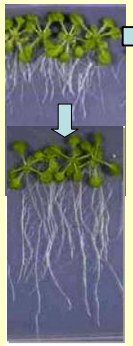
Genes for:
- Photosynthesis
- Root growth
- Oil synthesis
- Stress tolerance

Genetically-modified Jatropha with High Productivity

Molecular Breeding of Stress Tolerance



Improvement of root growth via gene transfer



Jatropha plants