

Seed Priming

Practical commercial use and its evaluation

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What is priming And its practical use

What is priming

Controlled, physiological stimulation of germination

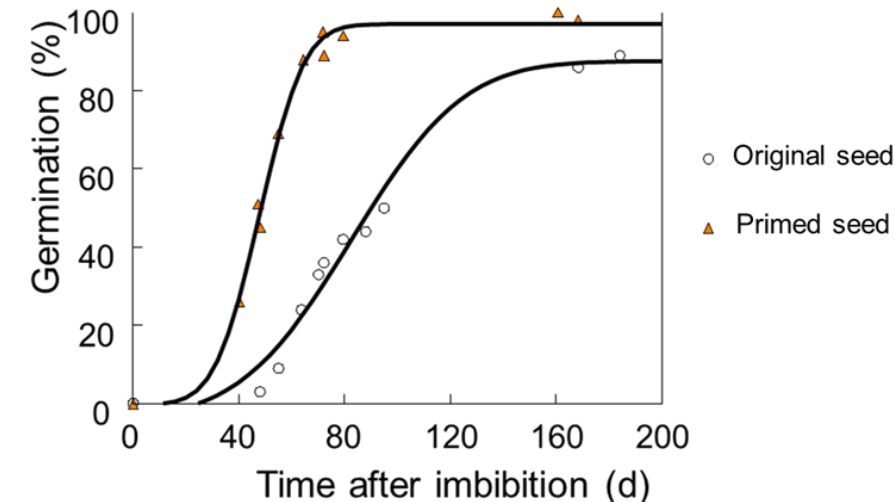
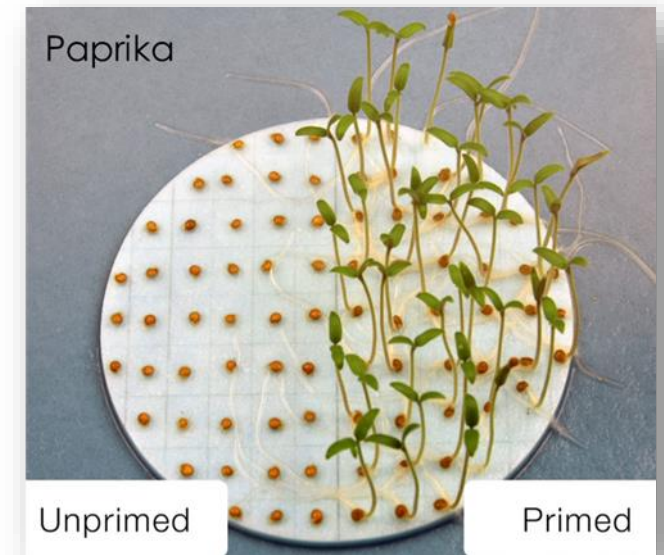
- Faster germination
- More uniform germination (synchronization)
- Improved germination under suboptimal conditions (salt, temperature, oxidative processes, ...)
- Relief from (primary) dormancy
- Prevention of (secondary) dormancy
- Seedlings less sensitive for stressful conditions

Combination with seed hygiene treatments

- Protect or repair the seed

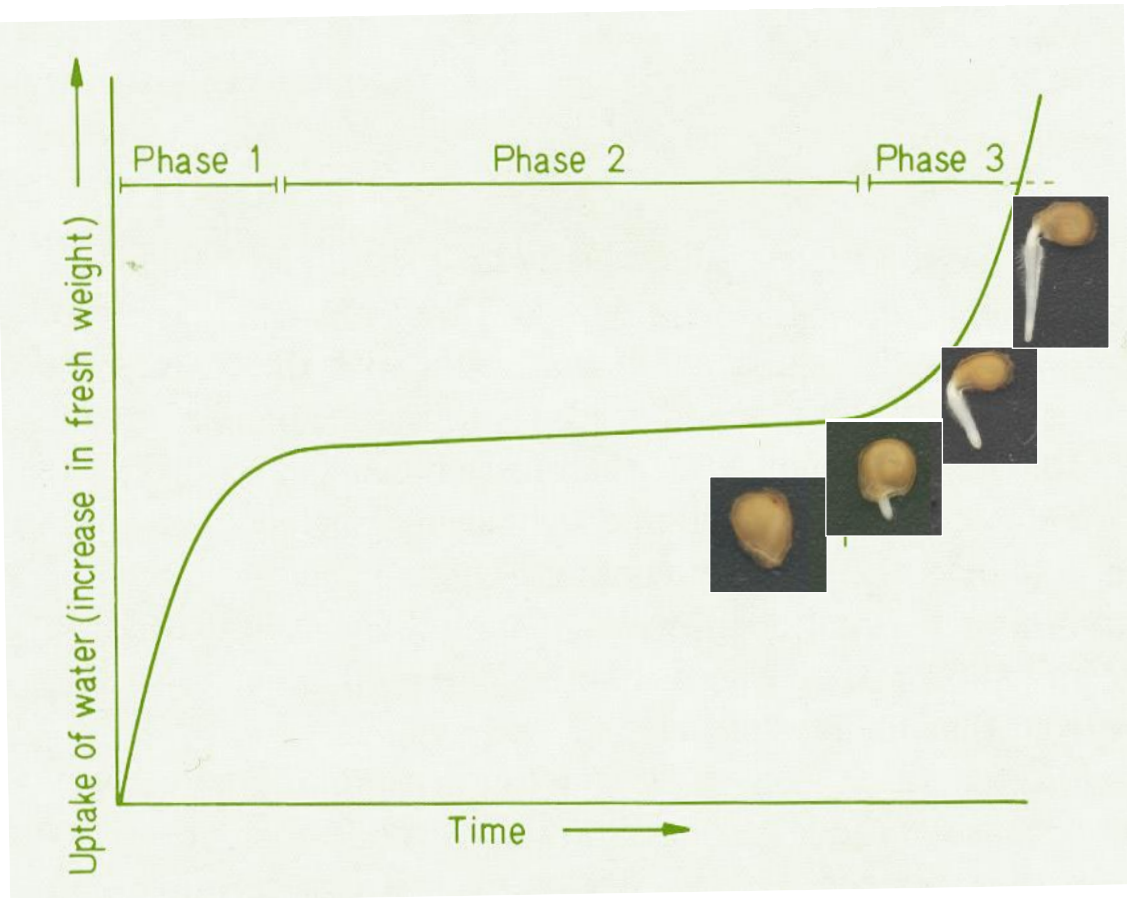
Improved seedling/plant performance

- Vernalization
- Addition of compounds or microorganisms

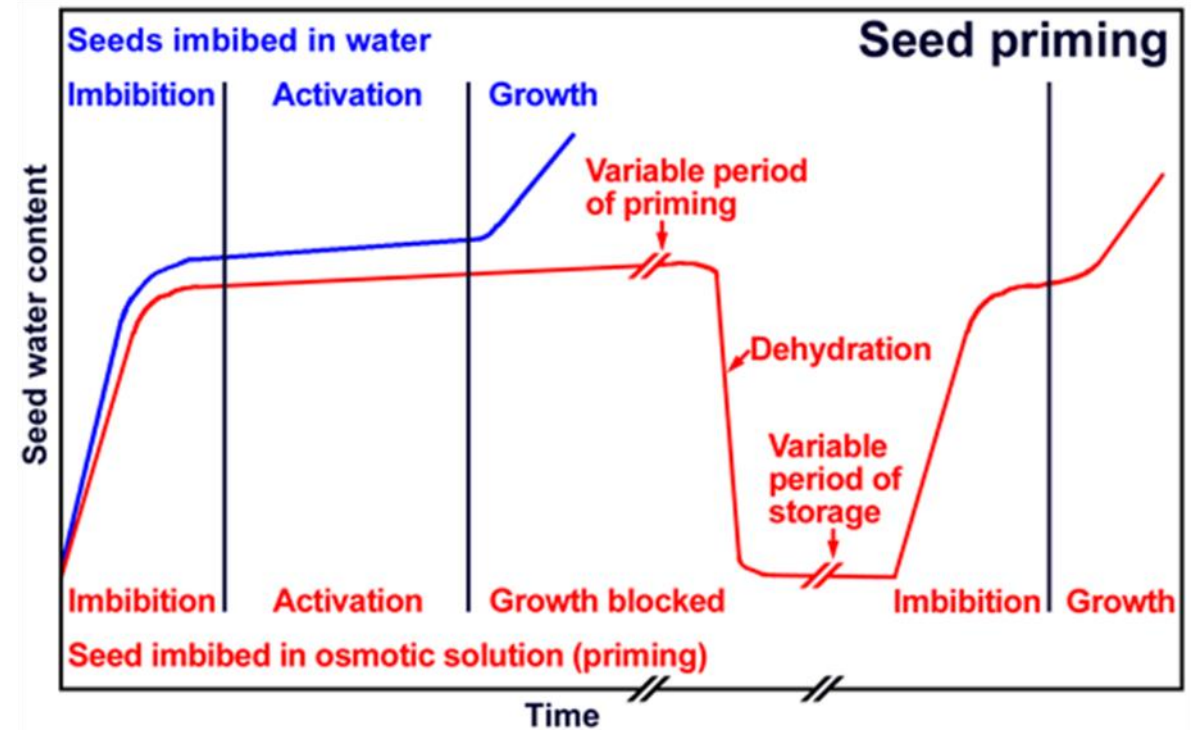


Principle of seed priming

- Water uptake of a seed is triphasic



- Principle of seed priming

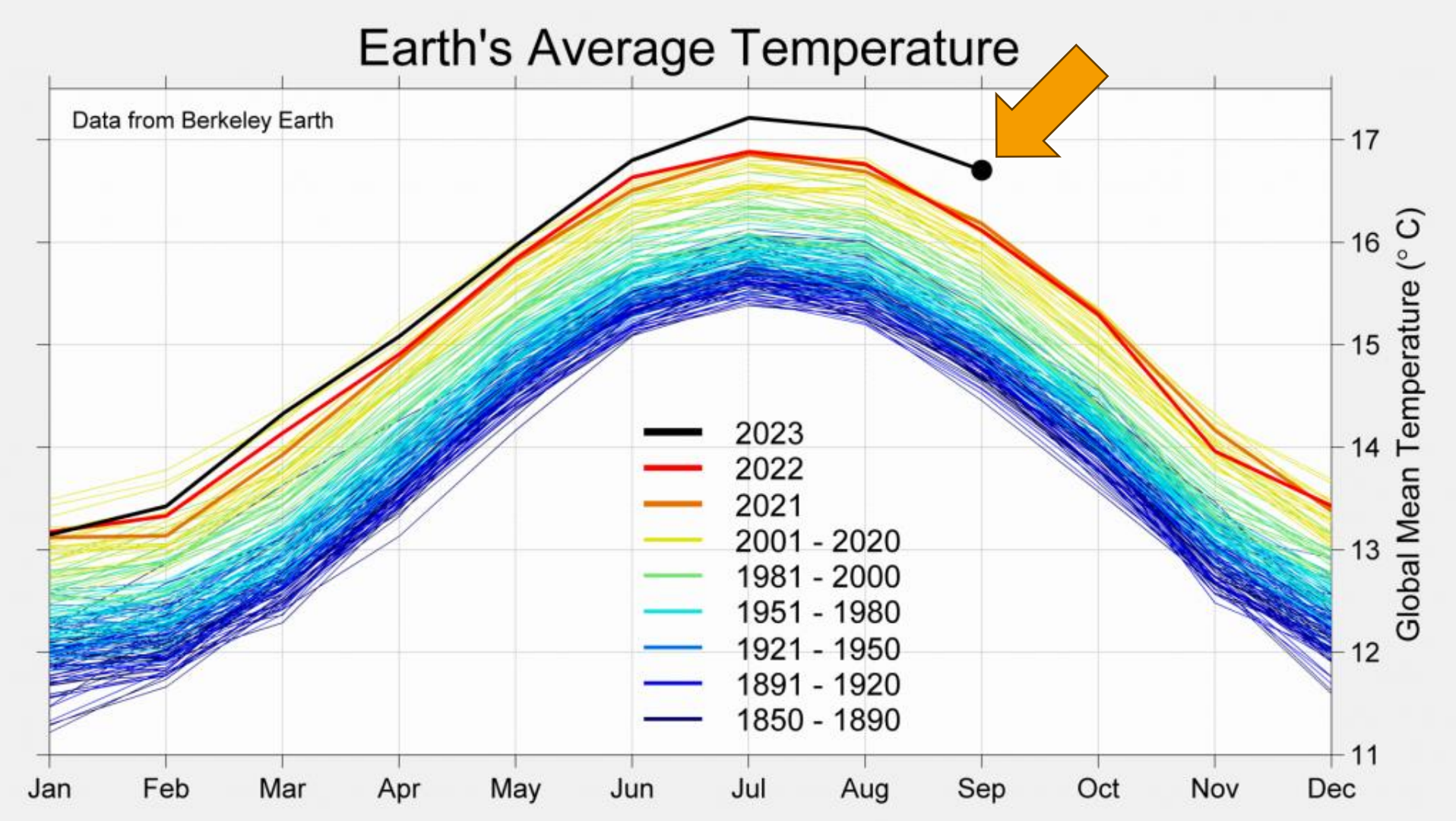


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Why priming is beneficial ?

- To get a **faster and more uniform germination**
- **Increase** germination, **faster** germination, better and **more useable transplants**
- **Abiotic stress** : Better germination under suboptimal conditions (temperature, drought, salt)
- Breaking **dormancy**
- Improve deteriorated quality





September 2023 Temperature Update - Berkeley Earth

For which crops?

Area	Crops
Europe	lettuce, rootstock tomato, other solanaceous spp. celery, fennel, carrot, onion, endive/chicory, sugar beet
USA	lettuce, onion, tomato, celery, brassicas, carrot, pepper, cucurbit spp., tobacco, sugar beet
S. America	carrot, lettuce, tobacco, endive
Asia	cucurbit spp., tomato, eggplant, pepper, lettuce, cumin
Japan	lettuce, spinach, tomato, eggplant, rootstock tomato, other solanaceous spp. , brassicas, carrot, onion, watermelon
Australia	lettuce, celery

Trends in priming

■ **New crops:**

- True potato seed (Europe)
- Gourds and cucurbits , papaya (Asia)
- Hemp, guayule (N. America)

■ **Organic priming:**

- Especially Europe and North America
 - Organic market in 2021 125 billion euro (increase of 3%)
 - 1.6% of the global agricultural area, 20 countries \geq 10%
- Brazil, Japan: slowly growing

How to evaluate priming effect

▪ Character of primed seed

- **Faster** germination
- Good **uniformity**
- Better germination at **suboptimal conditions** (low temp / high temp/ no light)

▪ ISTA method

- Designed to evaluate the **germination capacity at best condition** of each seed
- Germination speed / vigor / uniformities are not targeted
- Germination at suboptimal condition is not targeted

**Difficult to evaluate the priming efficacy
by ISTA germination test method**

How to evaluate priming effect

How to evaluate priming effect

Germination test on primed seed

- **Need to design germination test** methods to evaluate the priming effect and its benefit
- per species, varieties and seed lots (**depends on the purpose of priming**)

For designing of germination test on primed seed

- Need to understand **environmental condition** where each seed lot is sown
- **Proper Frequency of germination count:** Germination uniformity/ vigor
- **What abiotic stress** would happen ?

Lettuce (*Lactuca sativa*)



	Media	°C	Count (DAS)	Dormancy breaking
ISTA method	TP.BP	20	4-7	Pre-chill

Suggestion for both of raw seed and primed seed

	Media	°C	Count (DAS)	
Both of Raw seed / primed seed	TP	20	1-2-3-(7)	To know the germination speed / root development
	Soil test	20	5	Check the cotyledon condition
	Thermogradient test	16-36 (2 °C interval)	1-3	
	Repetition test (Soil test)	Each 4 months	5	

Expected Priming effect

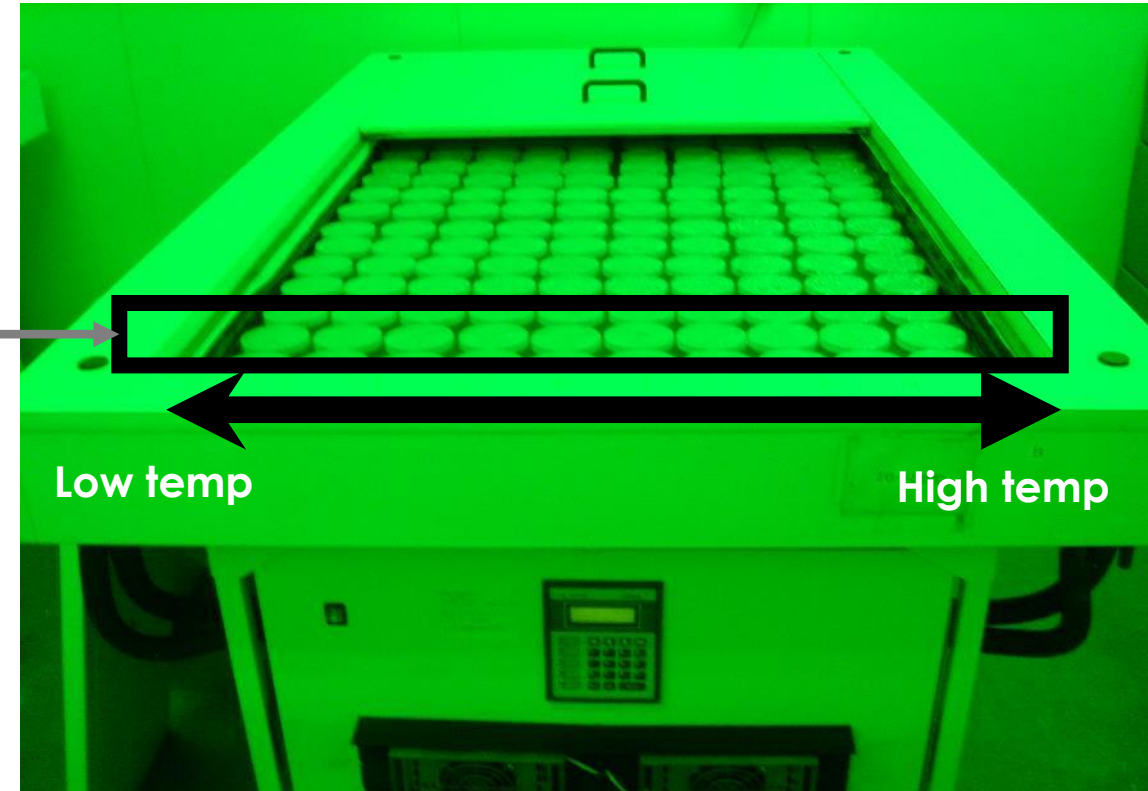
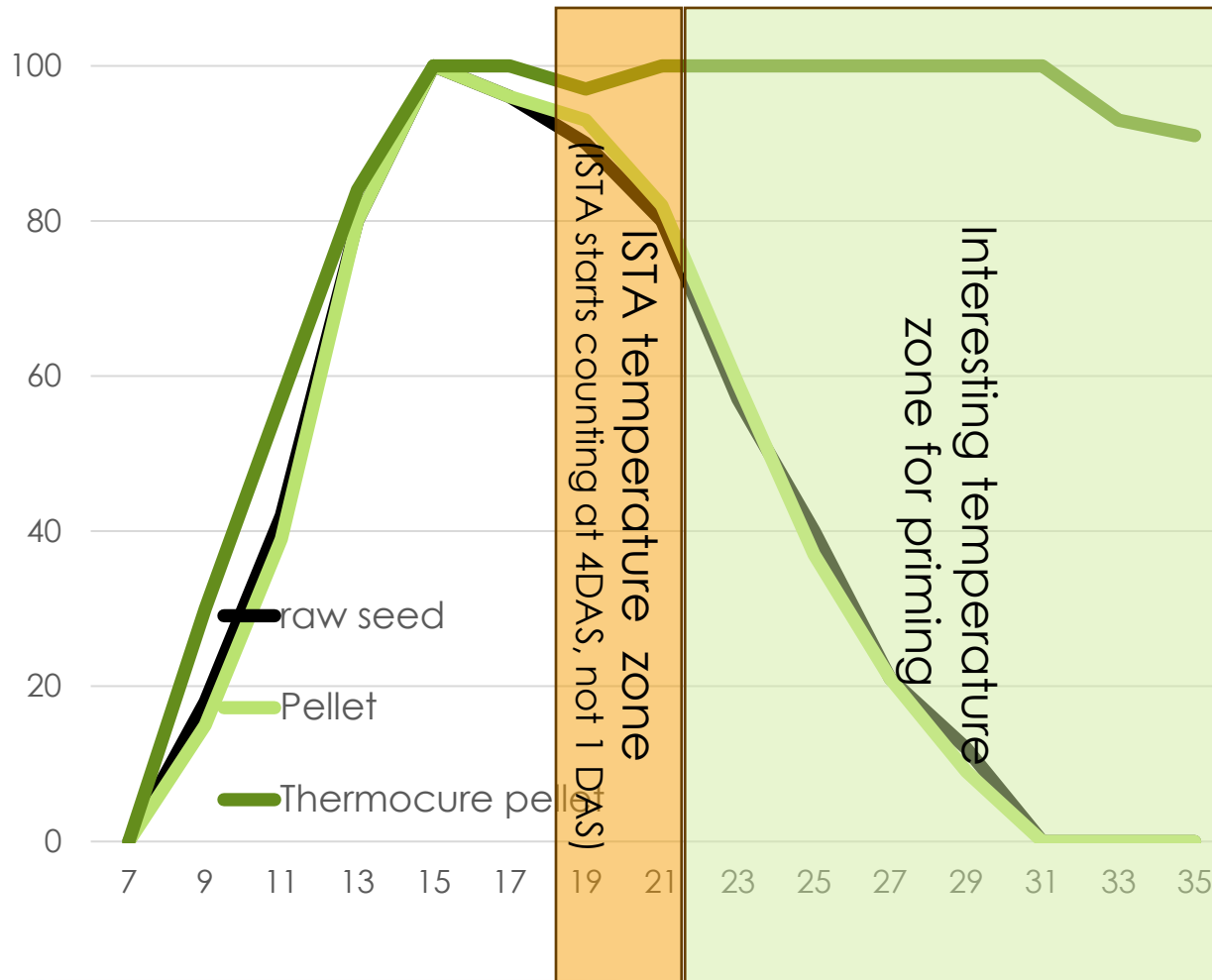
- Breaking of thermo-dormancy and photo-dormancy
- Good germination at high temperature and in darkness (pellet)
- Principally, thermo-dormancy is a type of secondary dormancy



Lettuce (*Lactuca sativa*)



Thermo-gradient test result (1DAS)



2°C interval
 Under green light
 10 tray / seed lot
 33 seeds / tray x 2 duplicates

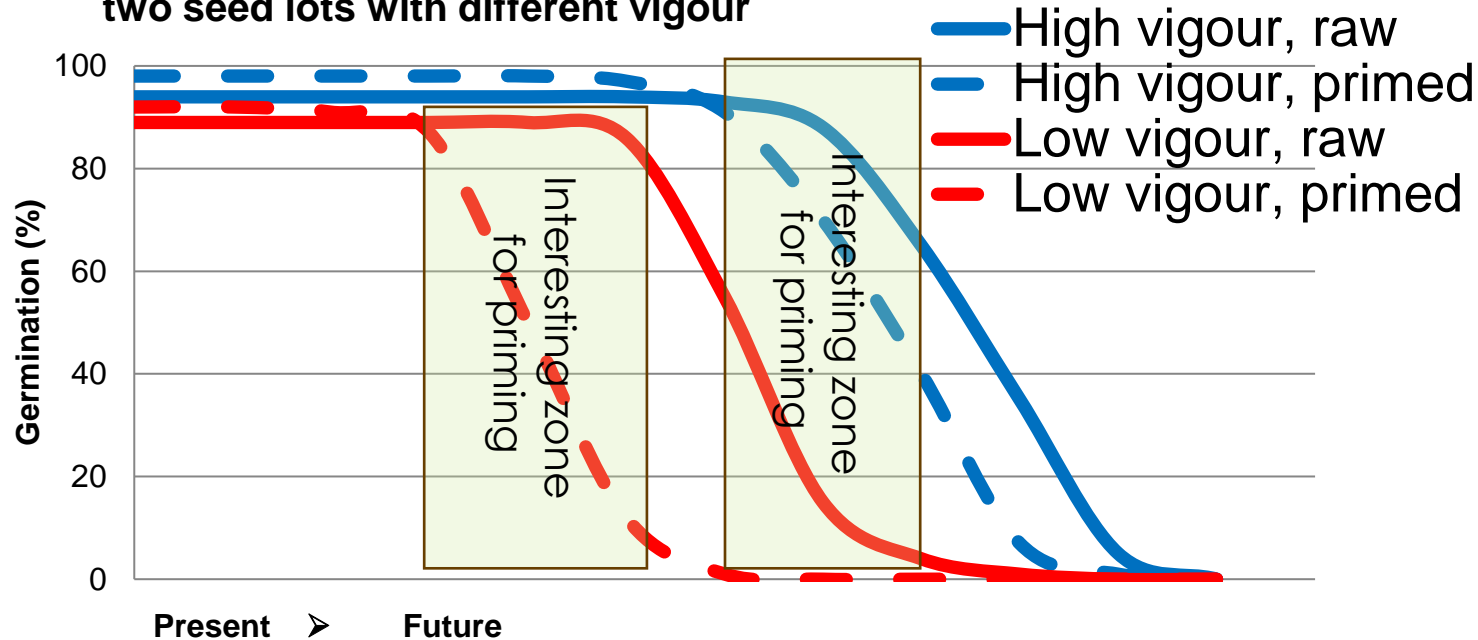
Lettuce (*Lactuca sativa*) - time lapse video



Lettuce (*Lactuca sativa*)

Risk in aged / low quality seed

two seed lots with different vigour



Healthy germination



Abnormal germination



Tips to use priming technology successfully :

- Low vigour seed lots may initially show positive results, but will **deteriorate sooner**
- Priming is not for **old** seed lots, nor lots with too **low** quality and vigor
- Optimization of the priming recipe : per seed lot , not variety
- Periodical repetition of test is important

Tomato (*Solanum lycopersicum*)



	Media	°C	Count (DAS)	Dormancy breaking
ISTA method	TP.BP	20↔30	5-14	KNO3

Suggestion for primed seed evaluation

	Media	°C	Count (DAS)	
For primed seed	TP (but dark)	15	3-5	To know the germination speed / root development
	Soil test	20	5-7-(14)	Check the cotyledon condition in lab
	Rockwool plugs (Europe)	25 ??	10-12	For checking the growth and size of the seedlings
	Thermogradient test	10-30 (2°C interval)	3-5-14	

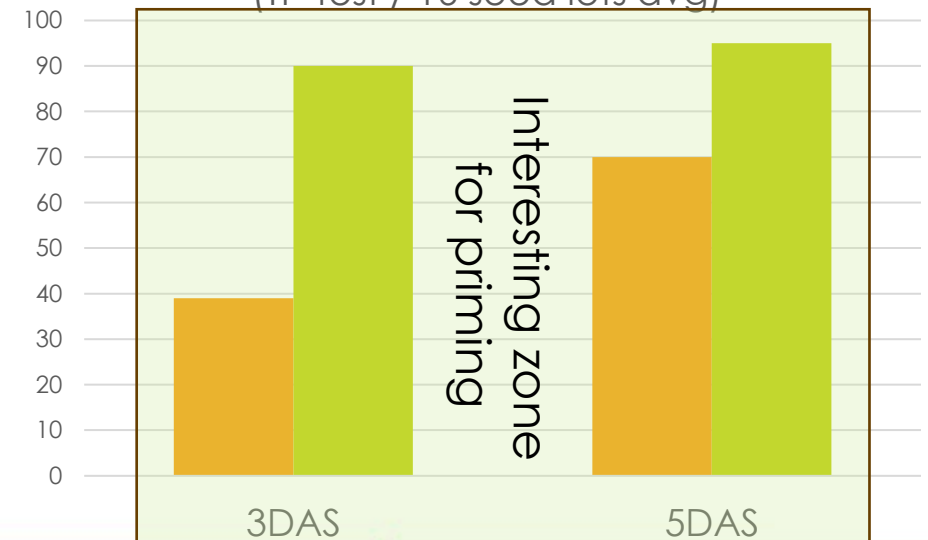
Expected Priming effect

- Faster and more uniform germination
- Better germination at low temperatures



Rockwool plugs test
Seedling size check

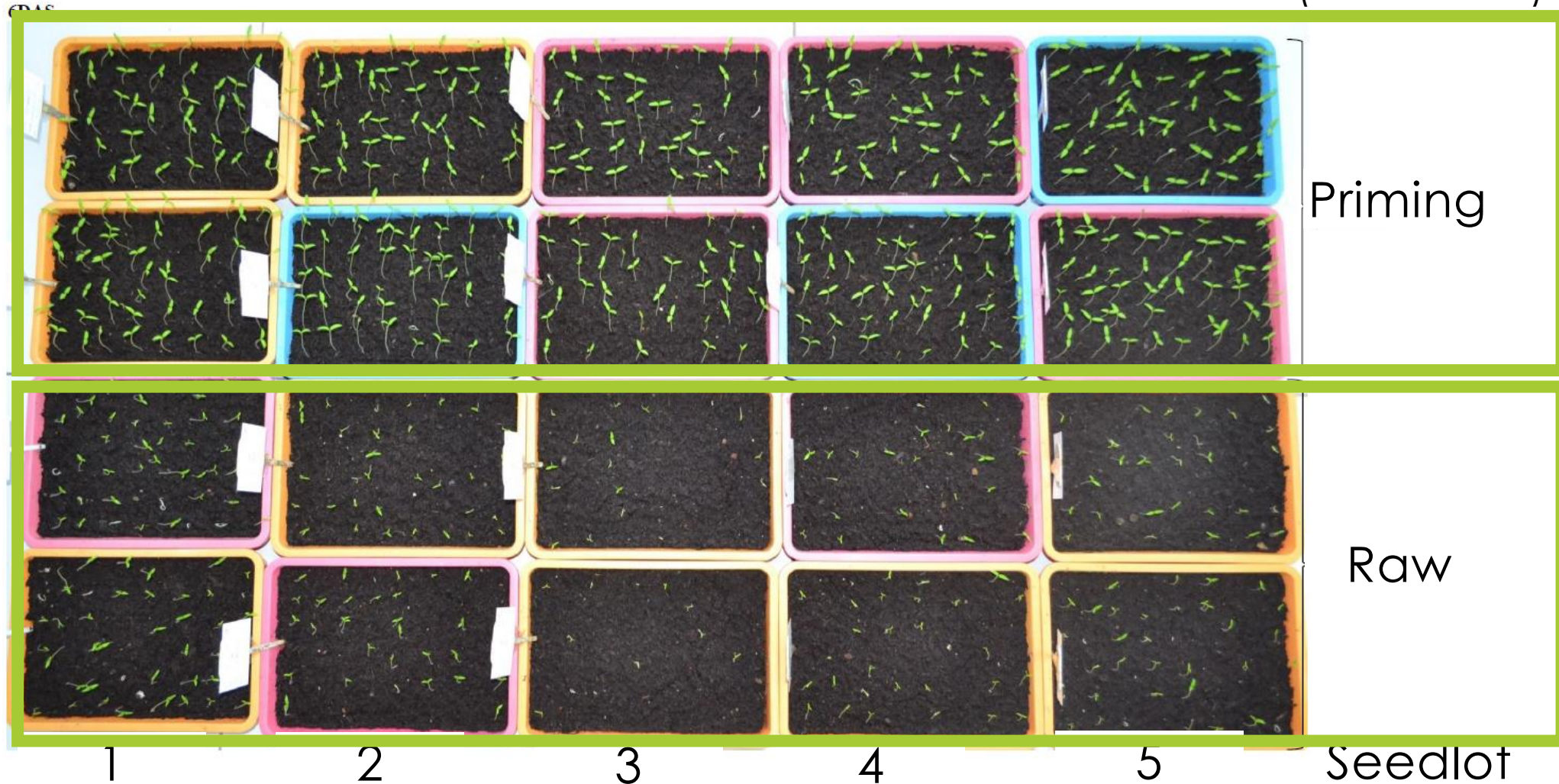
Tomato Priming effect @ 15°C dark
(TP-test / 16 seed lots avg)



Tomato (*Solanum lycopersicum*)



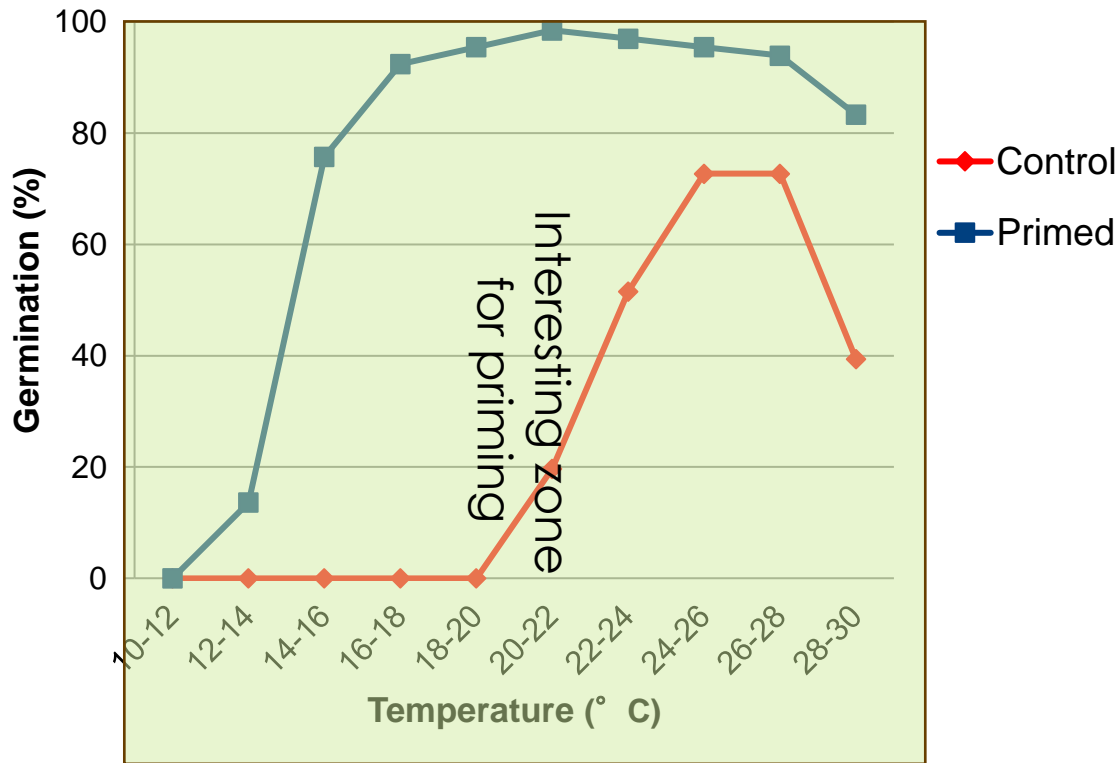
(6DAS@20°C)



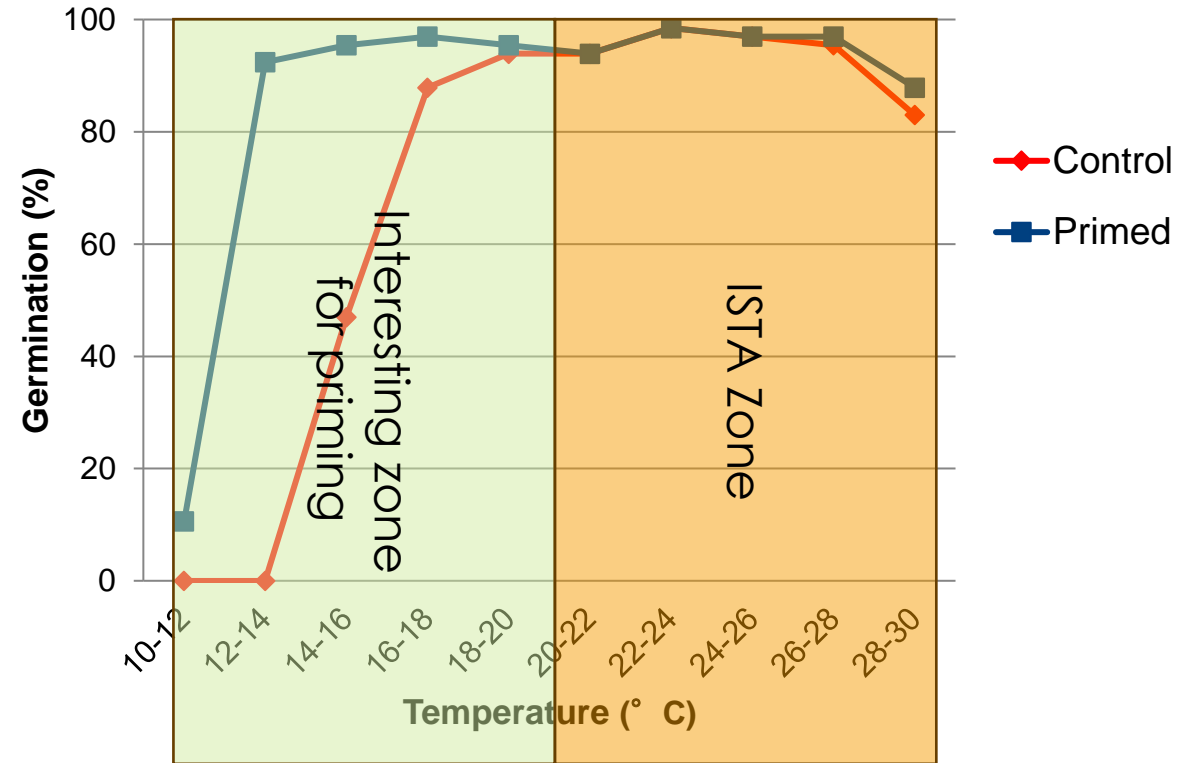
Tomato (*Solanum lycopersicum*)



Germination energy (3DAS) of tomato seed



Final germination (14DAS) of tomato seed



* ISTA start count from 5DAS

Tomato (*Solanum lycopersicum*) time lapse video



Root stock tomato time lapse video

Solanum lycopersicum x *Solanum habrochaites*
Solanum lycopersicum x *Solanum pimpinellifolium* etc



Root stock tomato

Solanum lycopersicum x *Solanum habrochaites*
Solanum lycopersicum x *Solanum pimpinellifolium* etc

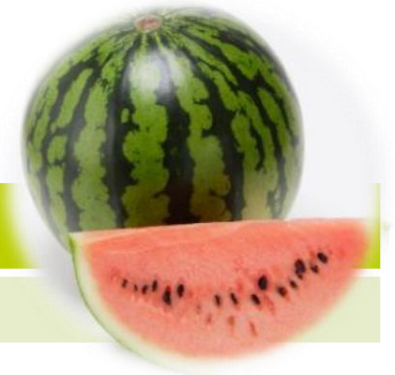


Original seed lot

Primed seed lot



Watermelon (*Citrullus lanatus*)



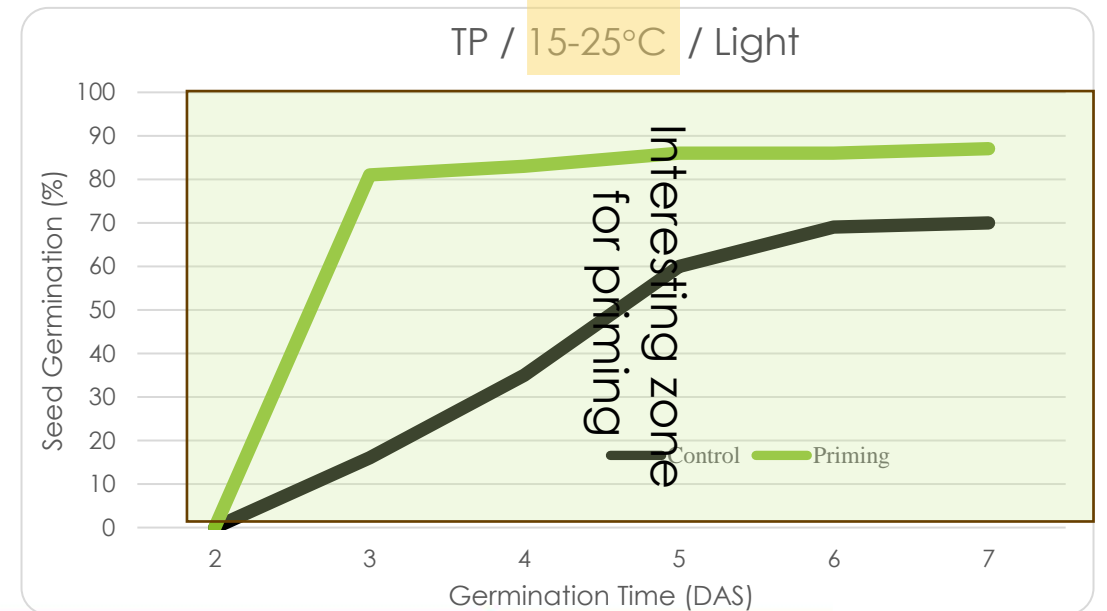
	Media	°C	Count (DAS)	Additional advice
ISTA method	BP, S	20↔30, 25	5-14	PP advisable

Suggestion for primed seed evaluation

	Media	°C	Count (DAS)	
Both of raw seed and primed seed	TP (light)	15↔25,	2-3-5-7	To know the germination speed improvement more clearly / root development
	Soil test	25	5-7-(14)	Check the cotyledon / seedling condition

Expected Priming effect

- Faster and more uniform germination
- Better germination at low temperatures



Bitter gourd (*Momordica charantia*)



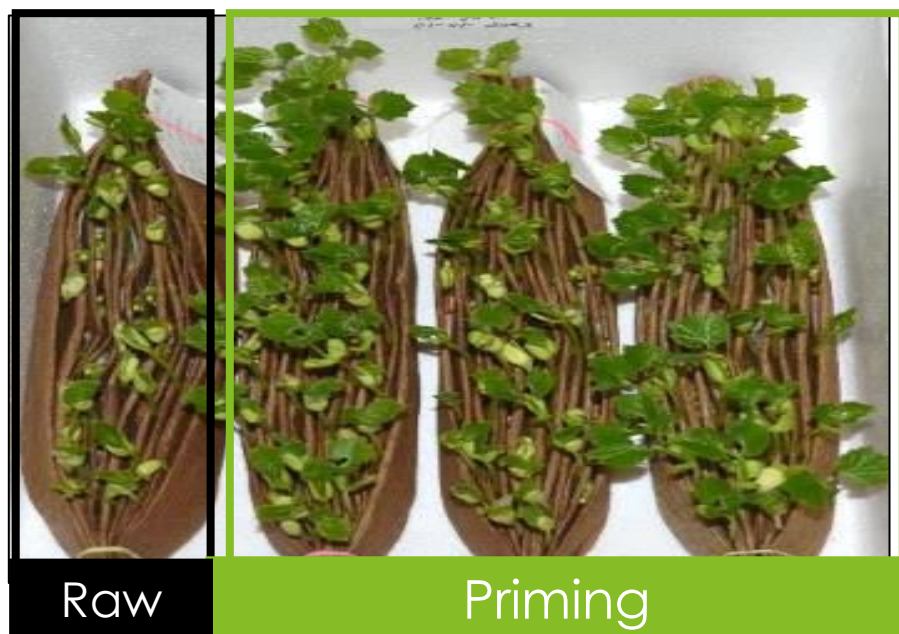
	Media	°C	Count (DAS)	Additional advice
ISTA method	BP , S	20 ↔ 30, 30	4-14	

Suggestion for primed seed evaluation

	Media	°C	Count (DAS)	
Both of raw seed and primed seed	BP (light)	15↔25,	2-3-5-7	To know the germination speed improvement more clearly / root development
	Soil test	25	5-7-(14)	Check the cotyledon / seedling condition

Expected Priming effect

- Faster and more uniform germination
- Better germination at low temperatures



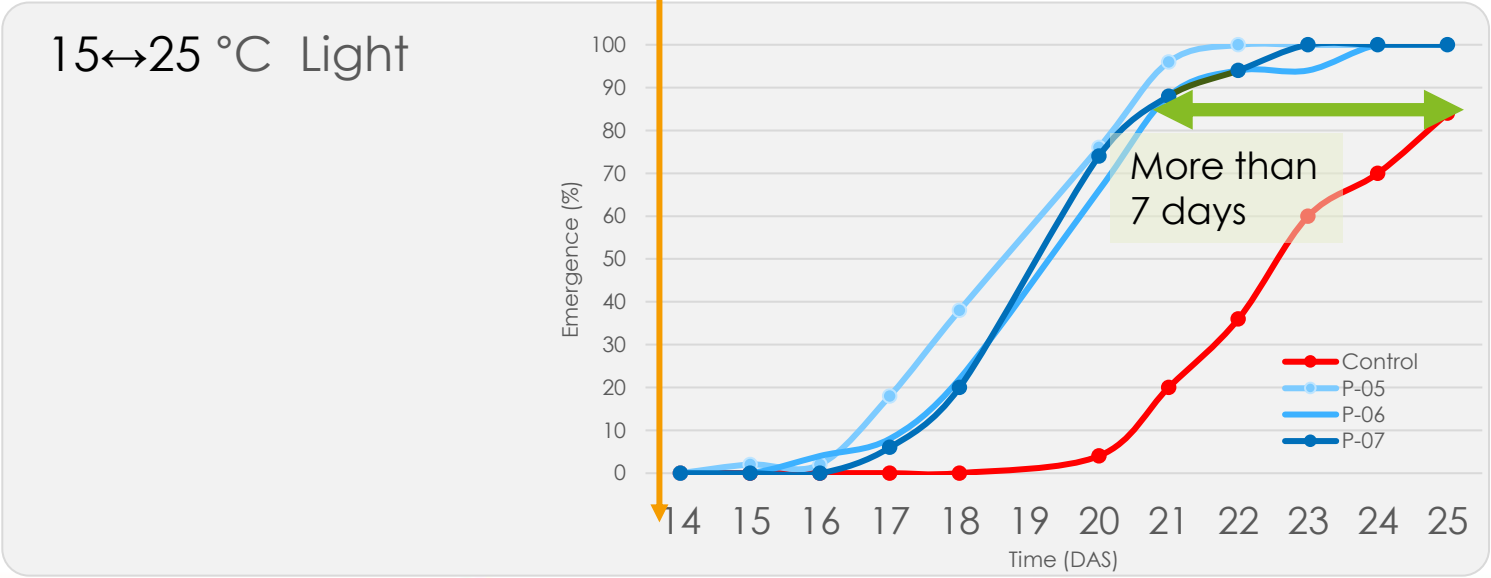
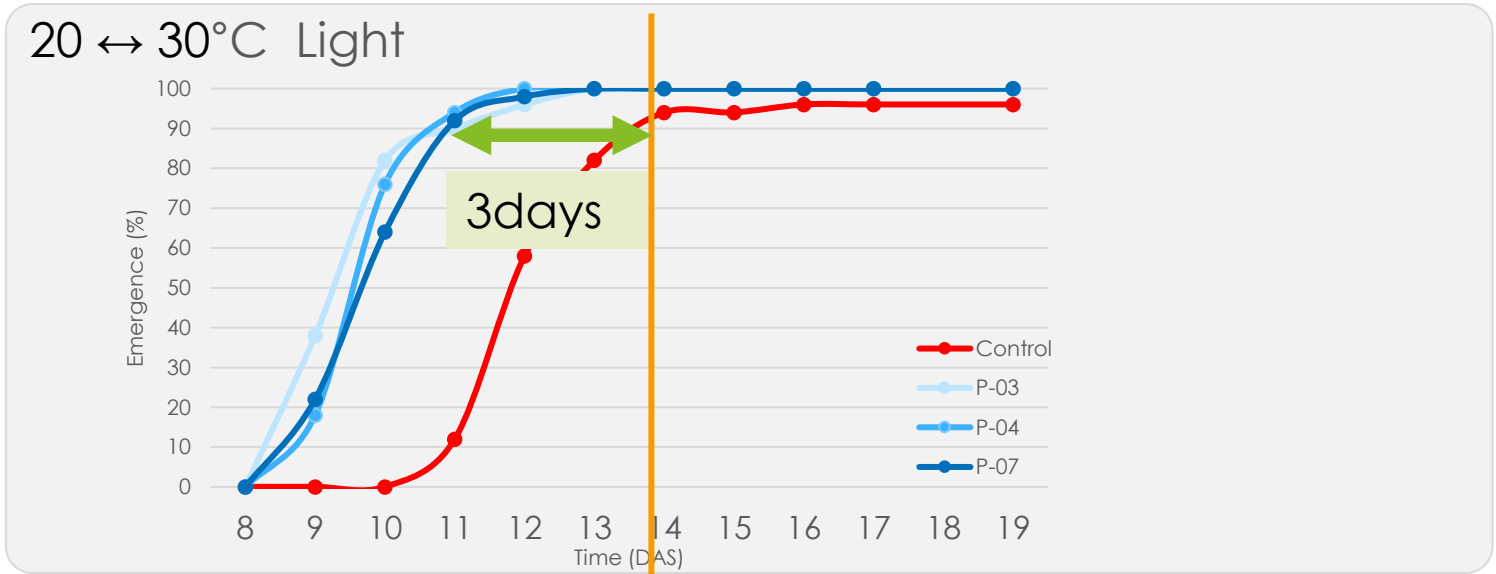
Raw

Priming

Bitter gourd (*Momordica charantia*)



CONTROL
PRIMING



Okra (*Abelmoschus esculentus*)



	Media	°C	Count (DAS)	Additional advice
ISTA method	TP, BP, S	20 ↔ 30, 30	4-21	

Suggestion for primed seed evaluation

	Media	°C	Count (DAS)	
Both of raw seed and primed seed	BP	15	2,3,4,7	To know the germination speed improvement more clearly @ suboptimal condition / root development

25 °C, Light, TP

20 °C, Light, TP

15 °C, Light, TP

Object	3DAS	Object	7DAS	10 DAS	Object	3 DAS	4 DAS	7 DAS
Raw	98	Raw	66	68	Raw	28	28	28
Primed	98	Primed	92	92	Primed	86	92	92

Expected Priming effect

- Faster and more uniform germination
- Germination speed improvement in **lower temperature sowing**

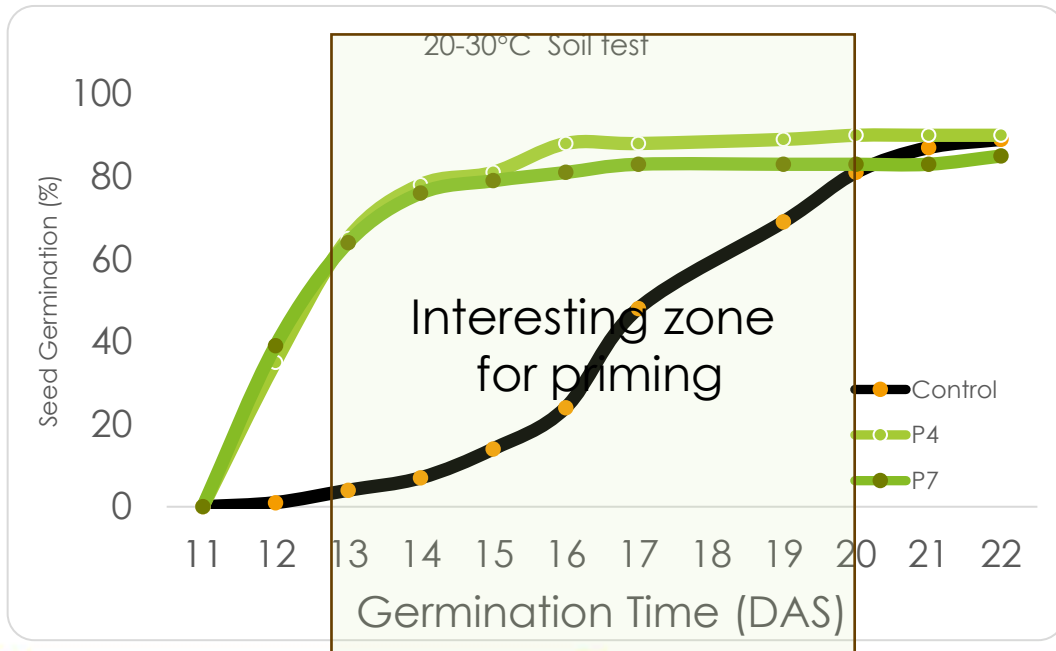
Papaya (*Carica papaya*)



	Media	°C	Count (DAS)	Dormancy breaking
ISTA method	S	20↔30,	12, 28	Soak in water for 16 h; soak in GA3 0.05 % for 16 h

Suggestion for primed seed evaluation

	Media	°C	Count (DAS)	
Both of raw seed and primed seed	Soil	20↔30	Frequent count from 12 till 21 Final would be around 21	To know the germination speed improvement more clearly



Expected Priming effect

- Faster and more uniform germination
- Germination takes around 21-28 days

Summary

Suggested germination test methods for primed seed

To know the **germination speed improvement** by priming clearly

- Start germination count earlier
- More frequent count
- GRUT = germination rate and uniformity test. Two counting per day to get exact description of germination speed and uniformity.
- Time lapse video

. To evaluate the germination improvement by priming **at suboptimal condition**

- Temperature stress test : testing at low or high temperature.
- Thermogradient test
- Moisture stress test
- Germination test at different light condition : Light / dark / light-dark

Suggested germination test methods for primed seed

To know the impact of **priming on Seedling quality**

- Plant type test : check cotyledon condition
- Useable Transplant test = test based on plant raiser evaluation, to determine percentage of seedlings that can be transplanted

To know the impact of priming on **shelf life**

- Storage test (check germination periodically)

Most important things are :

- To understand germination characteristics of each seed
- What priming effect are you expecting?

Acknowledgment



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