



Department of Plant and Environmental Sciences



# Cultivation optimization of quinoa production in Denmark

- an investigation of the influence of freezing, fertilization and harvest time

Cecilie Skovlund Løgi Christensen  
JFV515, Stud. Master of Agriculture  
Individual assignment  
Supervisor: Christian Andreasen  
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# Outline

- Background
- Problem
- Experimental setup
- Results
- Conclusions

# Background

- *Chenopodium quinoa* Willd. (quinoa) is a newly introduced crop in Denmark
- Agricultural knowledge is needed
- Poor seed quality has been reported



# Problem

1. Investigate if different **harvest times** and **amounts of fertilizer** (kg N/ha) influences germination and seed size of quinoa.
2. Investigate if **pre-treatment** of quinoa seeds with chilling and/or frost has an effect on the seeds in readiness to germination or release dormancy.



# Plantmaterial

Two cultivars used:

*Chenopodium quinoa* var. *titicaca* ('Titicaca') and  
*Chenopodium quinoa* var. *puno* ('Puno')

- Originates from the altiplano in Peru close to lake Titicaca
- Considered short day plants with a short growing phase



# 1) Field trial

- 5 amounts of fertilizer nitrogen:  
60, 120, 180, 80+40 and 120+60 kg N/ha
- 4 repetitions for each amount
- Sowing date: 29. of April 2010
- Harvest: 2. of August continuing once a week until November



# 1) Field trial

- 5 panicles harvested from each testing plot
- 1000 seed weight (g) measured
- 100 seeds germinated at 19°C from each lot in December 2011 – total germination noted



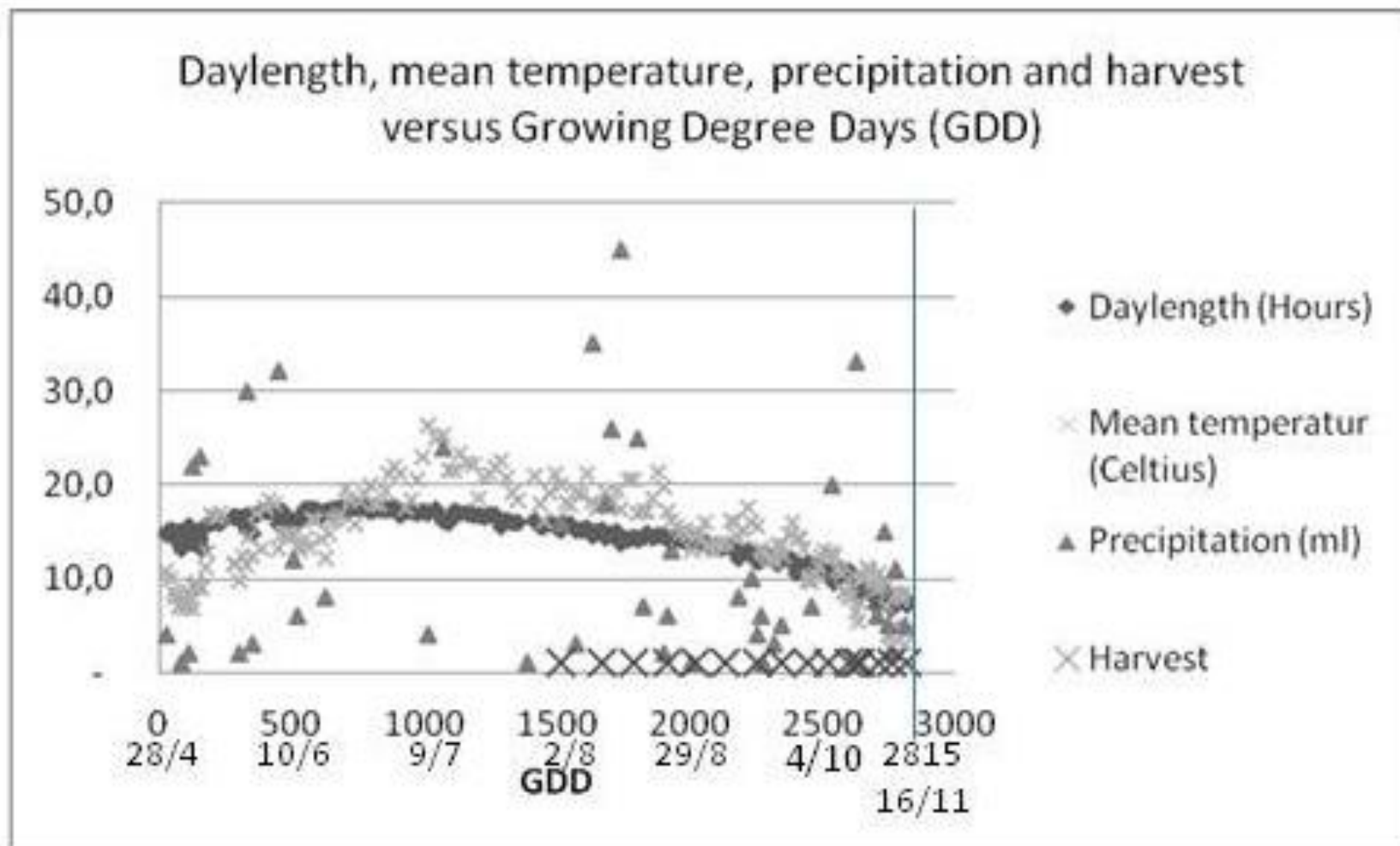
## 2) Germination experiment with pre-treated seeds

- 'Titicaca' harvested 14. of August 2010
- Frost (-21°C)
- Chilling (5°C)
- Stored for a period of: 1, 5, 9, 12 and 19 days
- 2 replicates of 100 seeds germinated at 20°C

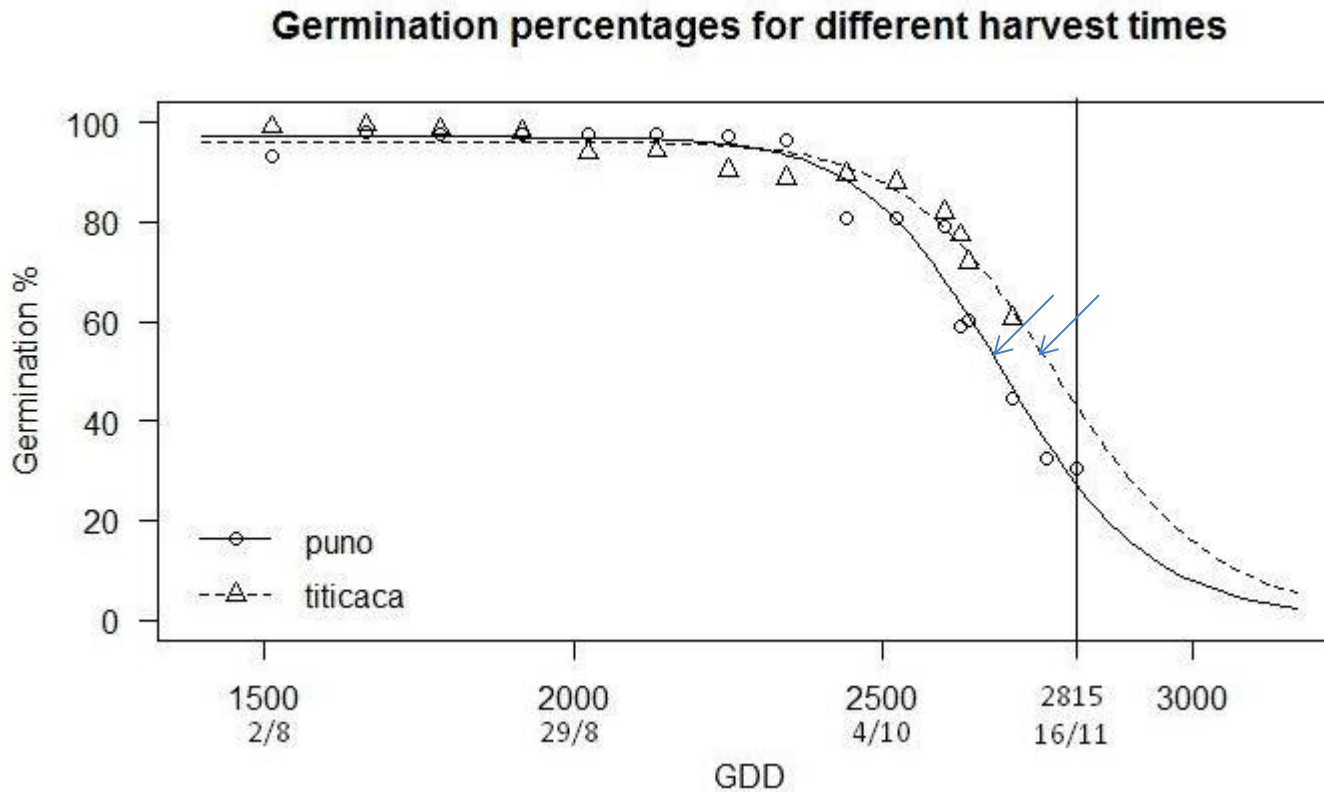




# Weather conditions 2010



# 1) Results germination



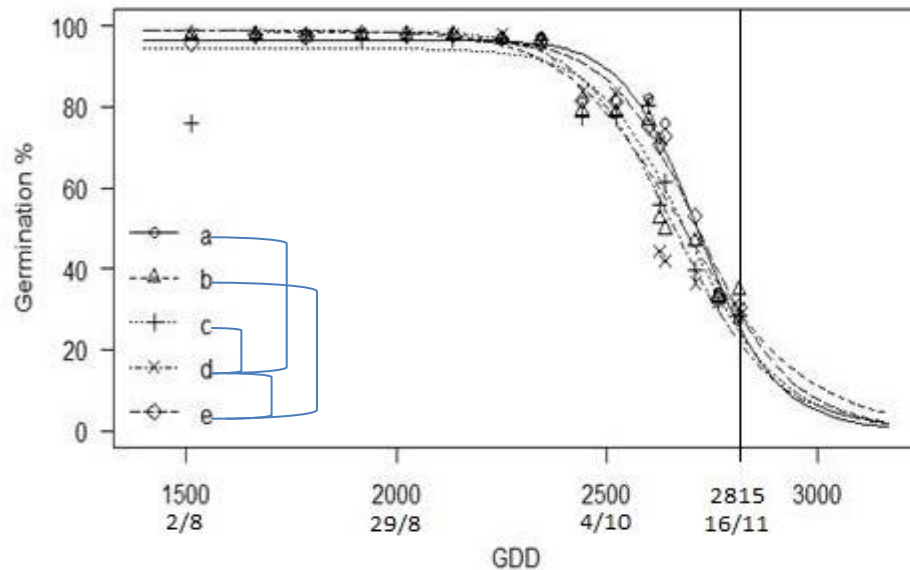
ED50 values: 'Puno'  $2700 \pm 4,85$  and 'Titicaca'  $1787 \pm 21,43$

Significant differences between cultivars,  $p$ -value of  $10^{-4}$

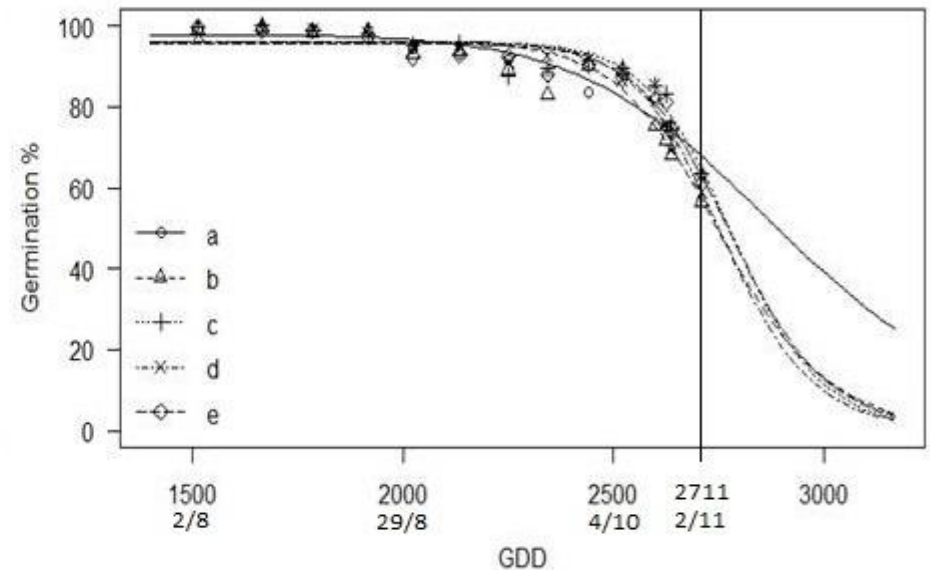


# 1) Results germination

A) Germination percentages for Puno plottet against Growing Degree Days (GDD)



B) Germination percentages for Titicaca plottet against Growing Degree Days (GDD)



The letters represents different amount of kg N/ha applied to the plots 2 days before sowing, a:60, b: 120, c: 180, d: 80 and e:120, d & e were also fertilized two weeks after sowing d:40 and e:60.

- Significant differences between fertilizer a & d, b & e, c & d and d & e for 'Puno'
- No significant differences between the amounts of fertilizers for 'Titicaca'



# 1) Results germination

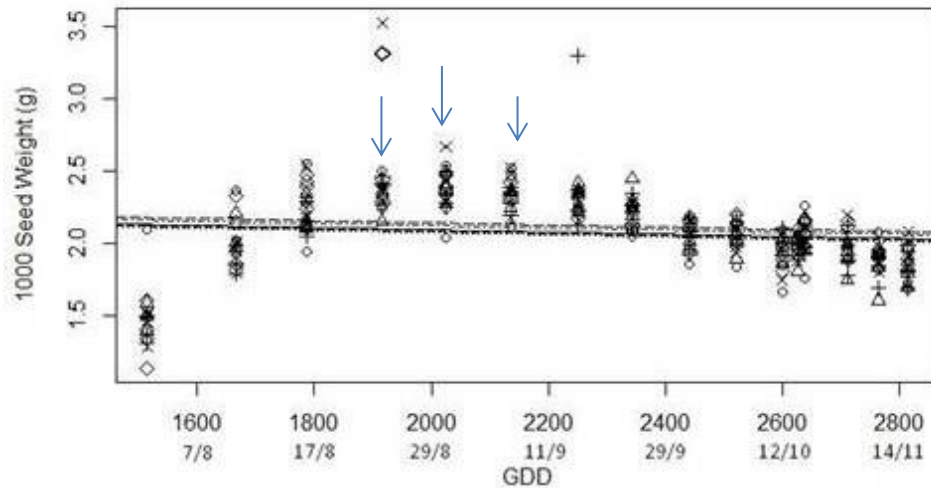
<b>Puno</b>	<b>ED50</b>	<b>Titicaca</b>	<b>ED50</b>
Kg N/ha		Kg N/ha	
60	2721 ±10,4 <sup>a</sup>	60	2858 ±68,6
120	2687 ± 14,2 <sup>b</sup>	120	2749 ± 20,2
180	2698 ± 12,0 <sup>c</sup>	180	2780 ± 29,4
80+40	2664 ± 11,7 <sup>a, c, d</sup>	80+40	2757 ± 21,3
120+60	2724 ± 12,0 <sup>b, d</sup>	120+60	2777 ± 28,6

Letters represents significant differences  $p < 0,05$

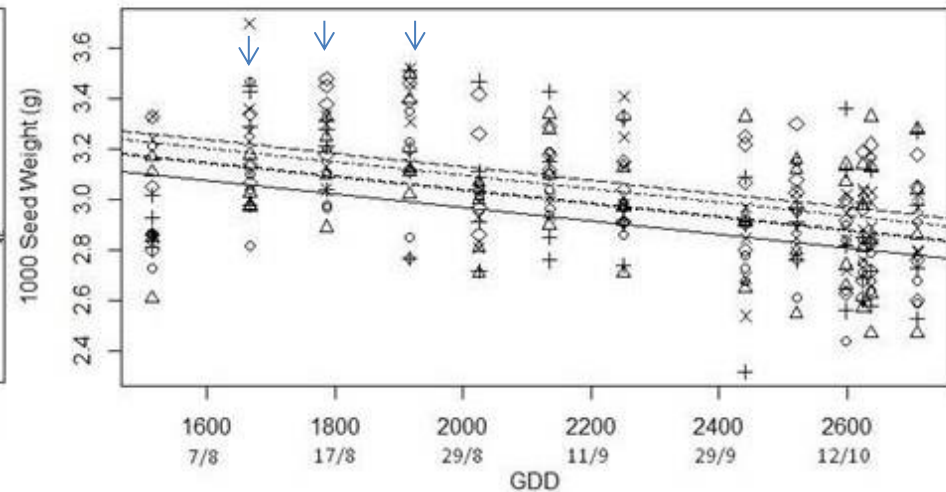


# 1) Results seed weight

A) 1000 Seed Weight (g) for 'Puno' plottet against Growing Degree Days (GDD)



B) 1000 Seed Weight (g) for 'Titicaca' plottet against Growing Degree Days (GDD)



- Significant differences between cultivars ( $p < 2.2e^{-16}$ )
- Significant differences between harvest times 'Puno' ( $p < 10^{-16}$ ) and 'Titicaca' ( $p < 1,606e^{-13}$ )



# 1) Results seed weight

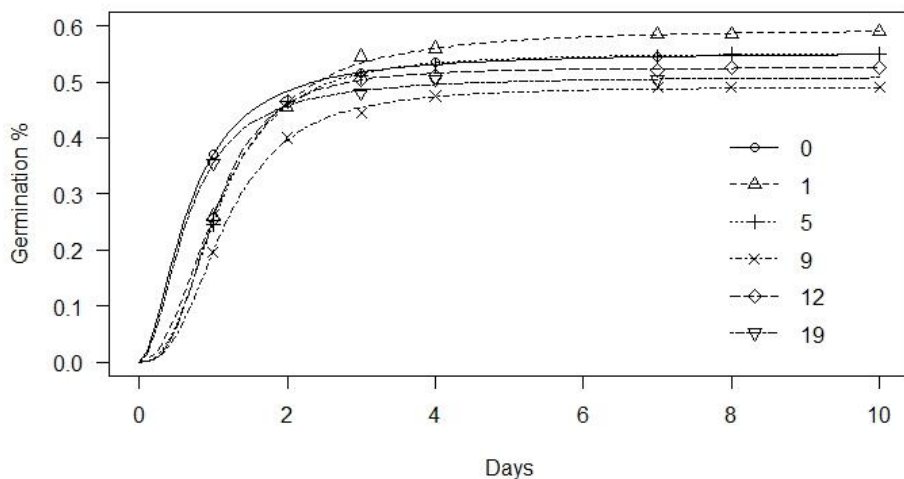
Intercept  $\pm$  standard errors for 1000 seed weights (g) for each amount of fertilizer for the two cultivars 'Puno' and 'Titicaca'. \*\*\* ( $p < 0,001$ ) and \*\* ( $p < 0,01$ ) indicates significant differences between the amounts of fertilizer compared with 60 kg N/ha.

Kg N/ha	'Puno' 1000 seed weight (g)	'Titicaca' 1000 seed weight (g)
60	2,32 $\pm$ 2,14e <sup>-1</sup>	3,50 $\pm$ 8,13e <sup>-2</sup>
120	2,29 $\pm$ 3,03e <sup>-1</sup>	3,58 $\pm$ 4,22e <sup>-2</sup>
180	2,03 $\pm$ 3,03e <sup>-1</sup>	3,57 $\pm$ 4,22e <sup>-2</sup>
80+40	2,23 $\pm$ 3,03e <sup>-1</sup>	3,63 $\pm$ 4,22e <sup>-2</sup> **
120+60	2,39 $\pm$ 3,03e <sup>-1</sup>	3,66 $\pm$ 4,22e <sup>-2</sup> ***

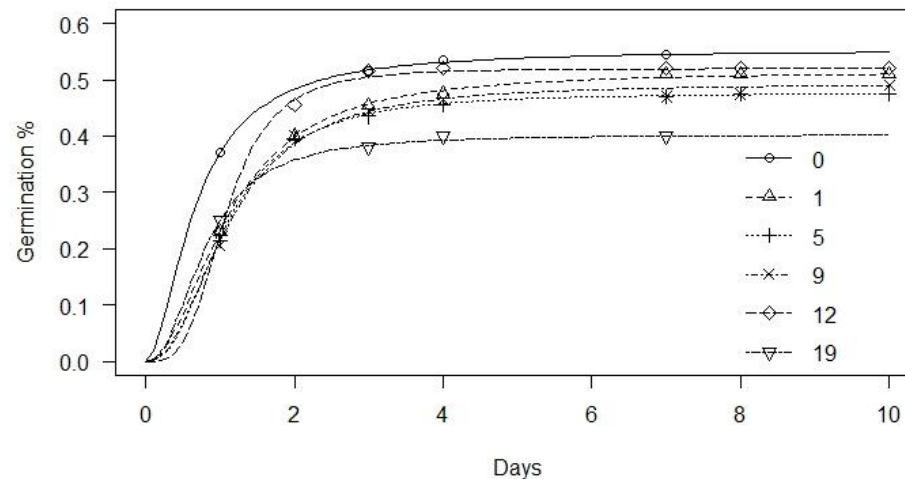


## 2) Results pre-treated seeds

Frost



Chilling



Days of treatment	Frost (-21 °C)		Chilling (5 °C)	
	Germination (%)	ED50	Germination (%)	ED50
0	54,5	0,68±0,10	54,5	0,68±0,10
1	59	1,13±0,09	51	1,11±0,10
5	55	1,08±0,08	47,5	1,08±0,09
9	49	1,17±0,08	49	1,13±0,10
12	52,5	1,01±0,07	52	1,08±0,06
19	50,5	0,66±0,10	40	0,81±0,09



# Conclusion

- Harvest time influences germination
- Fertilization do not influences germination
  
- Harvest time influences seed size
- Fertilization influences seed size for 'Titicaca' when fertilized twice compared with only 60 kg N/ha
  
- Temperature treatment of seeds do not affect germination





**Thank you for your attention**

**Questions**

