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Characterization of thermal needs of some tropical pulses

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Introduction

Europe lacks of local vegetal proteins and is highly dependent on imported soybean whereas the demand is increasing. Besides, people is looking for more sustainable and local food but, since the 50'-60' the production area of pulses has been decreasing in Europe, now representing less than 25%. The three main dry pulses cultivated in the North of France are pea, fava bean and now is starting the cultivation of soybean, but the two traditional crops encounter several agricultural issues such pest and diseases or yield variability and soybean has a bad societal image.

Worldwide there is a great diversity on pulses which could be suitable for temperate climate but the data available in the literature are scarce to evaluate the feasibility of production of those tropical pulses in temperate climates (Ayerdi & Marraccini, 2022). The aim of this work was to identify the thermal needs of several minor pulses in order to see the potential for cultivation in temperate climates.

Main hypothesis:

- Tropical pulses will germinate with temperatures above 10°C
- Growing degrees day necessary to reach maturity will be covered during the summer of temperate oceanic climate

Materials and Methods

The 9 minor pulses of the Fig 1 were used for the experiments. Minimal germination temperature was evaluated for 7 days at 6 temperatures: 8°C, 10°C, 12°C, 15°C, 20°C and 25°C. The sum of temperatures necessary to reach harvest was evaluated in three different growing conditions, in two greenhouses (controlled and uncontrolled temperatures) and on field (3 species) in 2021 in Belgium (- 50°29'54.8"N 4°44'28.4"E- 50.498566, 4.741219) sown on June 6th, following the main growing stages of each specie and recording the yield parameters: number pods, number seeds/pod, seeds weight.



Fig 1 Seeds of minor pulses tested in the study

Results and discussion

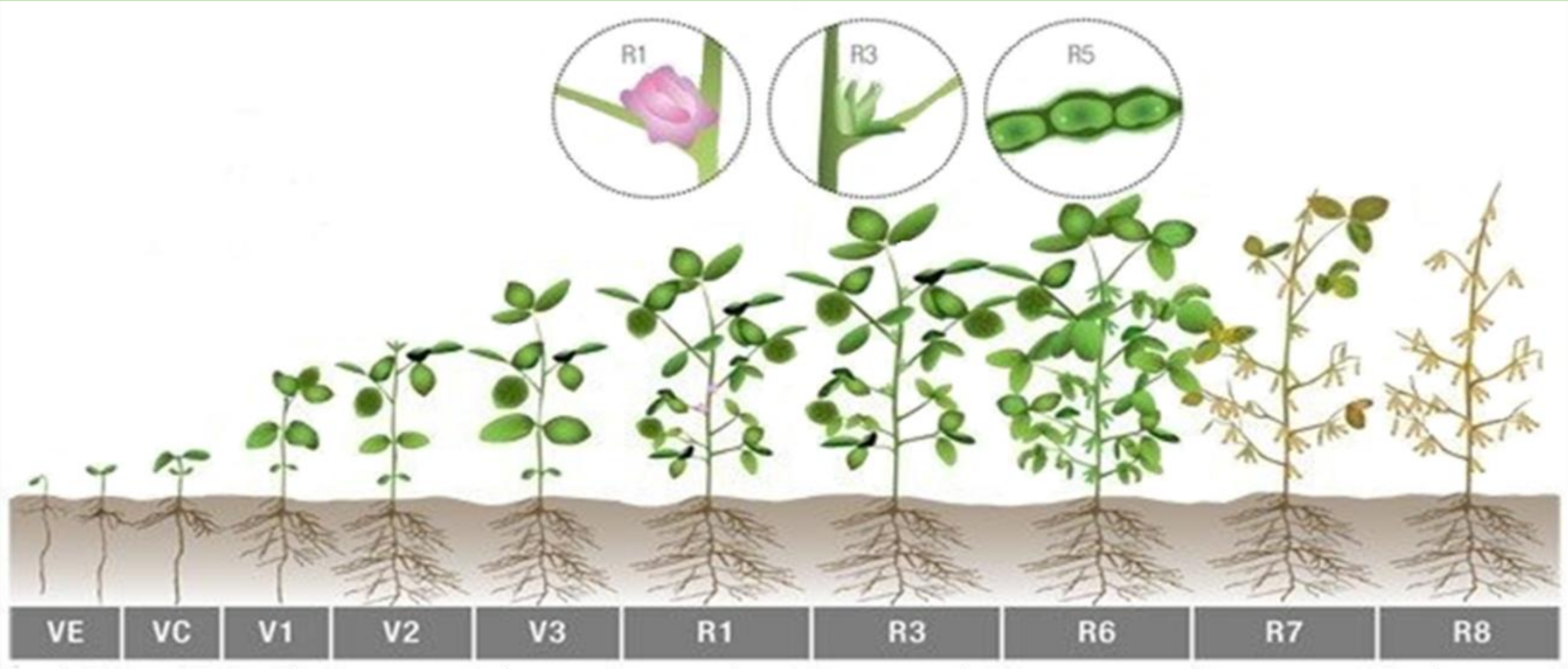
Pulses **germination** at different temperatures showed that at 5°C and 10°C there were no seed able to germinate. Above 15°C all the species were able to germinate. Only mung bean and cowpea germinated at 10°C. Pigeon pea, horse gram, rice bean and scarlett runner bean had the highest problems to germinate (Tab. 1). Probably it will be difficult to make them grow in temperate conditions. Adzuki, mung and cowpea presented a bigger ability to grow at low temperatures. Although only one genotype was tested for each species, regarding the resistance to cold temperatures it would be difficult to find genotypes with this trait in the diversity of those species.

	% Germinated seeds after 3, 7 & 12 days					
	5°C	8°C	10°C	12°C	15°C	20°C
Adzuki bean	0	0	0	0	5-61-100	13-72 -75
Chickpea	0	-	-	-	17-30-70	70-81-92
Cowpea	0	0	0-0-28	6-24-60	79-100-100	84-100-100
Horse Gram	0	0	0	0	-	-
Mung bean	0	0	27-59-68	35-59-82	81-93-100	95-96-96
Pigeon pea	0	0	0	0	0-2-10	25-56 -70
Rice bean	0	0	0	0	0-10-15	100
Scarlett	0	0	0	0	3-20-36	0-5-8

Tab. 1. Germination ability of 8 minor pulses at several temperatures

Once established the base temperature we determined the **growing degrees day** necessary to reach maturity (Fig. 2). Those data suggest that adzuki and mung beans could be cultivated with no much risk in the region, whereas rice bean will encounter problems for germination but could reach maturity, cowpea could be cultivated only in early sowing to be able to reach maturity on time. Field experience sowed that even with a late sowing because of rainy conditions and a cold summer, adzuki and mung bean can reach maturity before end of September, not possible for cowpea in those conditions. A sooner sowing, on more adapted dates like early may, could allow to reach maturity.

In Tab.2, Fig. 2 & 3 could be seen how look like the field and the **yield components** of the harvested pulses.



Species	Germination	1 st node	2 nd node	1 st flower bud	Flowering	1 st pods	Maturation	Senescence
Adzuki	110.72±12.73	224.00±2.83	278.30±12.37	481.43±43.88	508.05±49.36	536.25±53.74	843.08±59.57	946.00±109.04
Cowpea	95.67±47.24	232.28±14.53	257.75±3.54	619.15±78.84	662.43±86.73	713.45±99.91	1051.63±71.59	1186.20±120.63
Rice bean	105.41±5.22	191.15±0.57	224.00±2.83	400.95±33.23	427.78±32.00	4452.9±28.64	782.53±65.23	843.08±59.57
Mung bean	90.19±11.33	246.45±19.52	301.58±9.58	662.43±86.73	707.48±91.46	716.43±95.07	1051.63±71.59	1306.33±114.3
Scarlett	115.92±20.08	281.80±37.55	320.28±12.76	619.15±78.84	662.43±86.73	713.45±99.91	1063.13±87.86	1306.33±114.3

Fig 2. Mean growing degree day (°C) required to reach each developmental stage of each species, with a base temperature of 10°C, figure adapted from <http://blog.agriconomie.com/le-pois-et-le-soja/> 2014

Tab. 2. Main yield characteristics of several minor pulses, TKW: thousand kernel weight

Species	% Germination	Pods /plant	Pods /node	Pods lenght (cm)	Normal seeds /pod	Aborted seeds/pod	TKW(g)
Adzuki	63.89	8.60 ± 2.06	1.90 ± 0.91	8.97 ± 1.19	5.70 ± 1.59	0.70 ± 0.92	96.00
Chickpea	33.33	27.00 ± 8.27	1.00 ± 0.00	2.14 ± 0.20	1.00 ± 0.00	0.00	219.18
Cowpea	69.44	5.80 ± 1.33	1.71 ± 0.47	15.96 ± 1.68	5.65 ± 1.98	4.15 ± 1.81	191.44
Ricebean	50.00	10.00 ± 2.61	1.95 ± 0.89	12.36 ± 1.96	4.00 ± 1.45	0.35 ± 0.59	349.24
Mung bean	83.33	5.60 ± 2.24	2.00 ± 0.78	10.03 ± 0.76	6.20 ± 2.50	2.75 ± 1.21	52.97
Scarlett runner	11.11	3.00 ± 0.82	1.67 ± 0.82	29.33 ± 8.89	7.58 ± 7.03	1.92 ± 2.57	147.11



Fig 3. Mung bean, cowpea and adzuki bean the 17th September 2021 field in Belgium

Conclusions

According to those results, in temperate oceanic climate, it will be possible to sow some of the chosen pulses the second decade of May as it's already the case for Soybean with an slow growth the first days. Further research is needed on field to stablish the best sowing date, density and weeds management to increase the potential yield. Besides it will be necessary to look for more varietal diversity to increase the adaptability and suitability to this region.

Bibliography

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