Involvement of PI-WSCPs "Protease Inhibitors-Water Soluble Chlorophyll binding Proteins» in rapeseed adaptation to environmental constraints (PICADOR)

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Keywords

Rapeseed, proteolysis, chlorophyll-binding, Adaptation, Environmental stress, Senescence, Nitrogen use efficiency, Nitrogen remobilization efficiency

Agro ecology

Plant health

Genome and diversity

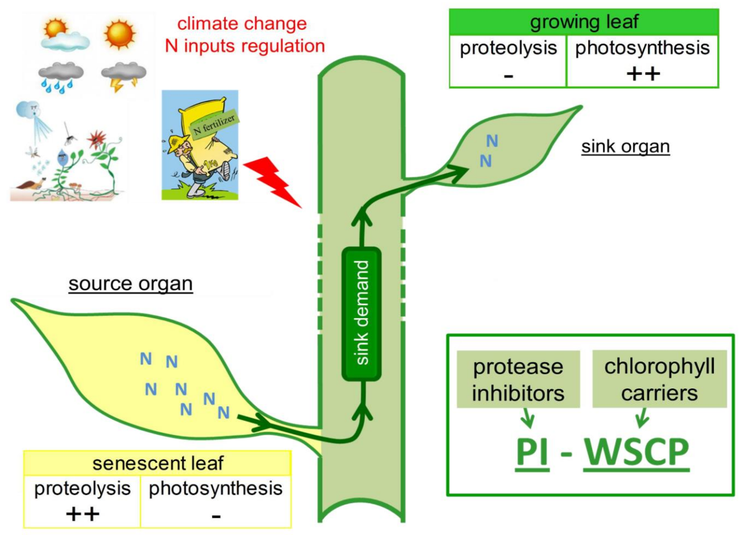
Social-economic context

Rapeseed is a crop of major economic importance, mainly grown for its oil-rich seeds in the context of food and non-food uses. It is the first oil crop in France. Despite its economic value, winter oilseed rape is a high nitrogen (N)-fertilizer consuming crop characterized by rather low N use efficiency (NUE). Since the last years, the importance of environmental constraints on this crop production has considerably increased, due to changes in agricultural practices with reduced inputs and global climatic changes. The major breeding challenge is now to improve nitrogen use efficiency and enhance tolerance to environmental stresses to ensure the competitiveness of this crop at agronomic, environmental, and economic levels.

Scientific context

In the context of climate change and N inputs regulation, attention is focused on improving NUE under abiotic stress to secure yield. A high proportion of assimilated N remains immobilized in senescent leaves and failing to contribute to seed yield. Enhancement of nutrient recycling and partitioning performance from senescing tissues to the growing and reproductive organs is likely to improve overall N remobilization efficiency (NRE).

Effective remobilization of N and C requires a fine tuning between sink demand, associated with photosynthetic efficiency and source supply related to proteolysis activity. In this context, PI-WSCPs, described as bi-functional proteins acting as both chlorophyll carriers and protease inhibitors, should be involved in maintaining the integrity of the photosynthetic apparatus and controlling the reallocation of proteolytic N.



Objectives

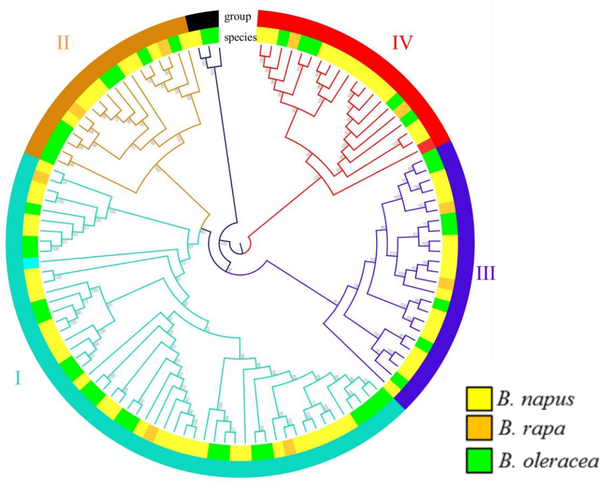
PI-WSCPs are duplicated intron-less genes grouped in 4 structural clusters. in rapeseed, around 30 genes encoding PI-WSCPs have been identified, which are expressed mainly in growing leaves and reproductive organs. They reveal differential expressions according to leaf development and stressful conditions. In silico approach suggests that PI-WSCPs could exhibited divergence between PI activity and chlorophyll binding capacity. Through their two biological functions and expression patterns, PI-WSCPs could be considered as: i) a lever to improve NRE from sources to sink organs in a context of climate change and N inputs regulation, (ii) factors to limit the damage caused by biotic aggression.

The aims of this PhD thesis are to :

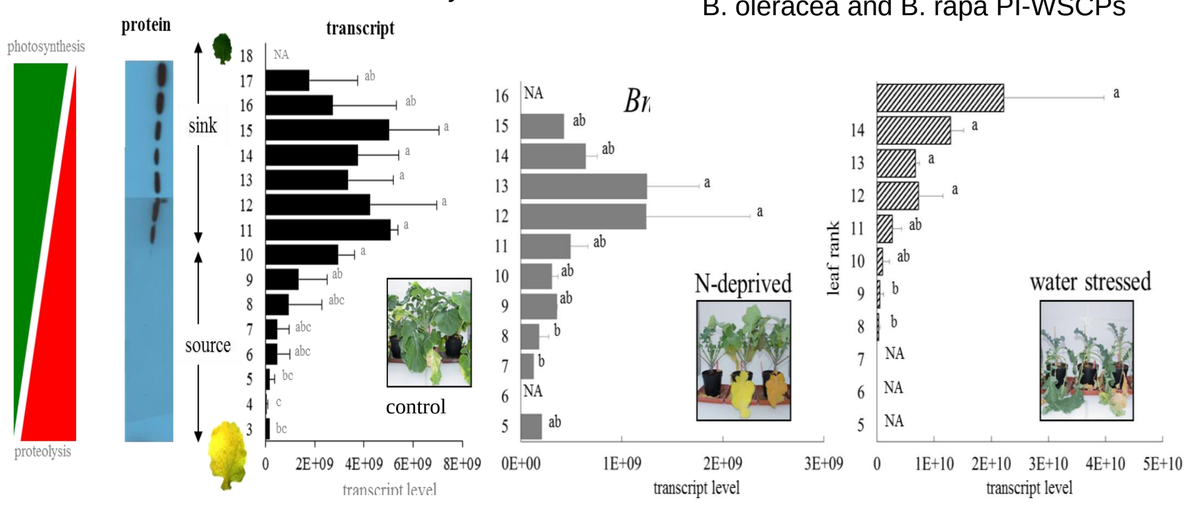
- clarify the structure-function relationships and biochemical properties of PI-WSCPs (enzymatic monitoring of PI activities and WSCP capacities using recombinant proteins, intracellular protein trafficking location, identification of protease partners)
- demonstrate PI-WSCPs contribution to cell protection in the case of multiple abiotic and biotic stresses (expression level in different oilseed rape genotypes with contrasted responses under abiotic or biotic stresses, functional validation by the creation of KO rapeseed).

PI anti Ser protease (70-100% probability)	WSCP	protein number
+	+	7
+		5
	+	5
		6

In silico proteins functions: redundance vs diversity



Dendrogramm of nucleic sequences of B. napus, B. oleracea and B. rapa PI-WSCPs



Leaf expression of BnaC06g33320D

Perspectives

The expected results should provide elements and tools to understand the plant response and adaptation to combined stresses (abiotic / biotic) and a better understanding of the functional involvement of PI-WSCP in NUE and NRE in rapeseed.