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Steps towards understanding variation for water and nitrogen uptake and use in *Brassica napus*

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Introduction

Water and nitrogen (N) are the biggest limiting factors in cropping systems around the world. Along with agronomic practices, breeding for limited N and water availability will increase profits of crop production. Existing variation for N and water uptake and utilization, and for drought tolerance/ avoidance mechanisms among *Brassicas* (1, 2) could be useful in improving canola for adaptability and sustainability. Identifying the underlying traits to high N use efficiency (NUE) and water use efficiency (WUE) could help select for highly productive cultivars under low N application and variable water availability.

Objectives

- Identify crop and plant physiological and biochemical traits that are closely related to NUE, WUE and to drought tolerance/avoidance mechanisms in *B. napus*
- Develop high-throughput screening methods and protocols for identified traits
- Assess variation within primary and secondary gene pools of *B. napus* for the selected traits
- Phenotypically characterize germplasm resources such as the spring *B. napus* Nested Association Mapping population currently under development

Preliminary results

1- NUE experiments

Canola genotypes were grown under low and high N availability in greenhouse and field, and compared for N uptake, N utilization and yield.

Average biomass, plant N, and yield of canola genotypes grown under two rates of N in the field and greenhouse

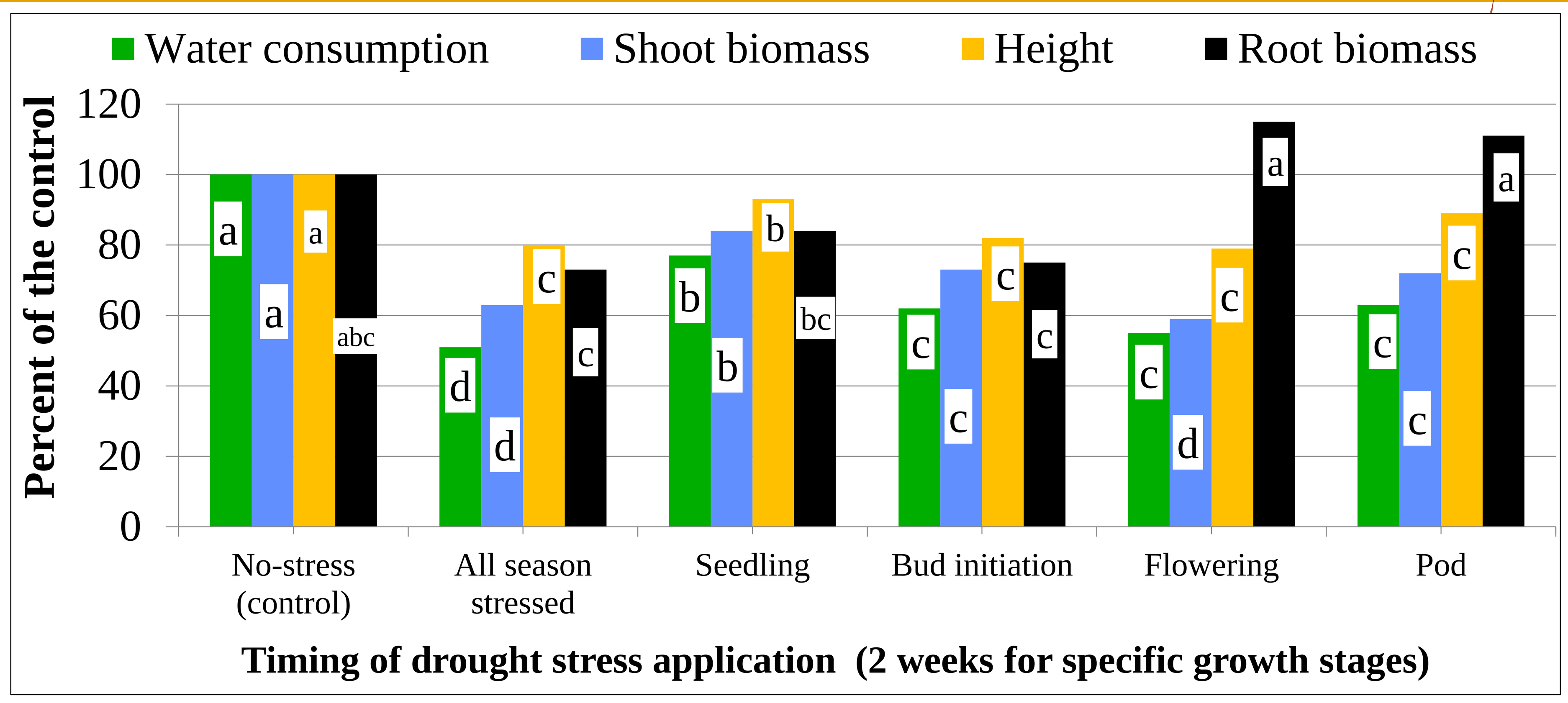
		Greenhouse				Field location	
		Leaf N	Stem N	Plant N	Biomass†††	Yield (kg ha^{-1})	
Soil N	Genotype	%	%	mg plant^{-1}	g plant^{-1}	Scott	Vanguard
Low N †	Hybrid	0.93^{e}	0.6^{e}	202^{cd}	15^{ef}	380^{b}	1551^{a}
	DH12075	0.9^{e}	0.9^{cd}	71^{e}	12^{f}	340^{b}	608^{bc}
	TIP2 (2)	1.0^{de}	0.7^{de}	187^{cd}	11^{f}	333^{b}	382^{d}
	N00-C171	1.0^{de}	0.8^{de}	140^{de}	12^{f}	--	--
	N99-508	1.2^{cde}	0.7^{de}	150^{de}	12^{f}	--	--
	YN01-429	0.85^{e}	0.5^{e}	141^{de}	13^{f}	--	--
High N ††	Hybrid [a]	1.7^{bc}	0.8^{de}	420^{b}	27^{ab}	513^{a}	1600^{a}
	DH12075	1.5^{bcd}	1.2^{abc}	241^{c}	29^{a}	603^{a}	838^{b}
	TIP2 (2)	1.9^{ab}	1.3^{a}	614^{a}	22^{bcd}	559^{a}	532^{c}
	N00-C171	2.4^{a}	1.3^{ab}	420^{b}	18^{de}	--	--
	N99-508	2.4^{a}	0.9^{cd}	395^{b}	21^{cd}	--	--
	YN01-429	1.9^{ab}	0.7^{de}	412^{b}	23^{bc}	--	--

Means within a column followed by the same letter are not significantly different ($P < 0.05$). † Low N was 150 mg N pot^{-1} in the greenhouse and 0 Kg N ha^{-1} in the field - †† High N was 750 mg N pot^{-1} in the greenhouse and 160 kg N ha^{-1} in the field - ††† Above ground biomass

- ✓ Variation for total plant N content and N partitioning among leaf, stem and pod were identified among the genotypes under high N only
- ✓ Days to flowering and maturity affected plant N accumulation and partitioning
- ✓ Canopy closure, leaf area duration, leaf chlorophyll content, and N remobilization will be included in future studies

2- WUE experiment

Eleven canola genotypes were grown under six watering regimes: i) Fully watered as control (80% of the soil water holding capacity), ii) low water treatment (50% of soil water holding capacity during plant life cycle), two weeks water stress starting from iii) seedling, iv) bud initiation, v) flowering, vi) pod filling. Two weeks stressed plants received 30% of the soil water holding capacity. Plants were watered every other day.



Means of each trait (colour coded in legend) followed by the same letter are not significantly different ($P < 0.05$).

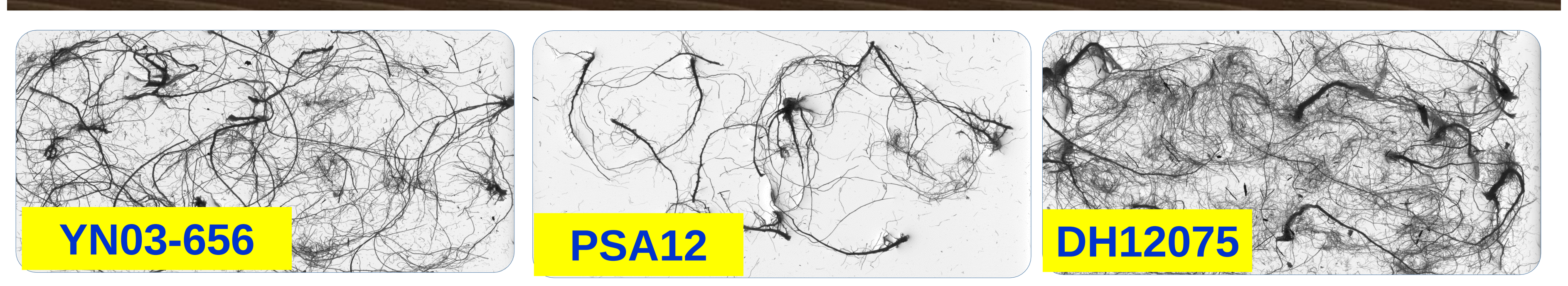
Above: Response of the genotypes to the watering treatments

Below: Variation of the genotypes, averaged over the water treatments

Genotype	Total water use	Plant height	Shoot biomass	Root mass	SPAD readings*
	(cm^{3} plant^{-1})	cm	(g plant^{-1})	(g plant^{-1})	--
86004	11830 b	113 cd	26 ab	0.78 a	48 bcd
81N064 -5	7940 d	106 d	14 gh	0.23 gh	52 a
DH12075	14013 a	124 ab	28 a	0.61 b	48 bcd
DH38060	9609 c	106 d	18 ef	0.31 feg	50 bc
Karat	11788 b	110 d	22 cd	0.52 bc	45 de
N00 – C125	11414 b	120 bc	24 bc	0.41 cde	47 de
N99 – 508	10653 b	106 d	18 ef	0.34 def	49 bcd
PSA12	5720 e	109 d	12 h	0.14 h	55 a
Yickadee	10646 bc	108 d	20 de	0.45 cd	52 ab
YN03-656	13355 a	131 a	26 ab	0.39 def	48 bcd
YN04-C1213sp09	10194 c	126 ab	19 ef	0.29 efg	44 e

* SPAD readings, recorded prior to flowering, reflects leaf chlorophyll content
Means within a column followed by the same letter are not significantly different ($P < 0.05$).

- ✓Two weeks of water stress substantially reduced plant water consumption; whereas biomass reduction due to the stress varied by the treatment
- ✓Genotypes substantially varied for total water consumption, for water consumption after two weeks stress, and for rooting systems
- ✓Stress at seedling had the least effects on plant biomass and stress at flowering had the greatest negative effect among the stressed treatments
- ✓ Mechanisms of drought tolerance depended on the time of water shortage. Plants recovered shoot-biomass growth after the seedling stress, but had reduced height and extended roots due to the stress after flowering
- ✓DH12075 consumed the most water and produced one of the largest biomass, whereas PSA12 had the lowest water usage and root mass



Root images of three genotypes of fully watered plants in the greenhouse

References

1- Gan et al. 2004. Can. J. Plant Sci. 84: 697–704.
2- Svečnjak and Rengel. 2004. Field Crop Res. J. 97: 221-226.

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