The importance of branching and branches characteristics on oilseed rape genotype x nitrogen interactions.

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Abstract Classical yield components analysis can be highlighted for winter oilseed rape by an architectural analysis of morphology and morphogenesis during the reproductive phase. For two conventional genotypes (Aviso and Montego) cultivated under usual agronomic practices and two nitrogen availability levels, the differences observed in grain yield mainly rely on branching and branches characteristics. The analyse of the dynamics of branching, pod setting and grain growth allows to decipher the different processes involved and to precise their dependence on genotype.

Key-words: thousand grain weight, pod, main stem, ramification, axis, earliness.

Introduction

It is well established that oilseed rape (OSR) grain yield dramatically relies on soil nitrogen availability (Allen and Morgan, 1971). Using classical yield components analysis, it can be demonstrated that average grain weight, number of grains per pod, and number of pods per plant are all affected, and depend on genotype characteristics (Habekotté, 1993). On the other hand, OSR is an indeterminate flowering crop, characterised by the sequentiality of axes and pods development (Jullien *et al.,* 2011). This characteristic of OSR development could explain part of the observed results concerning yield components analysis. We hypothesized that an architectural analysis of plant morphology and morphogenesis, mainly concerning grains, pods and branches during reproductive period, could be useful to decipher the processes involved in genotype x nitrogen interactions. In this aim, we analysed the dynamics of grain growth and pod setting on all the branches, for different genotypes under two nitrogen availabilities.

Material and methods

The experimental design consisted of two OSR genotypes slightly differing in precocity (Aviso & Montego), cultivated under two nitrogen availability regimes (N- = 30 kg/ha ;

N+ = 110 kg/ha) in Rennes (France) in 2009-2010. From the beginning of flowering to harvest, we measured at 8 dates with 3 replications OSR morphological compartments dry matter, and morphology characteristics (number, mass and dimensions of axes and pods).

Results

Grain dry weight dynamics (fig 1) indicates that final yields ranged from 3,4 to 4,3 T/ha according to nitrogen availability and seemed to be independent of genotypic earliness. In addition, we observed that for the two genotypes, about 2/3 of the yield was due to first order ramifications, and that this ratio was modulated by nitrogen availability.

Oilseed rape yield by unit of soil surface is the product of both Thousand Grain Weight (TGW), and number of grains by unit of soil surface (Gn):

$$Yield\,(T/ha) = Gn \times TGW(g) \times 10^6$$

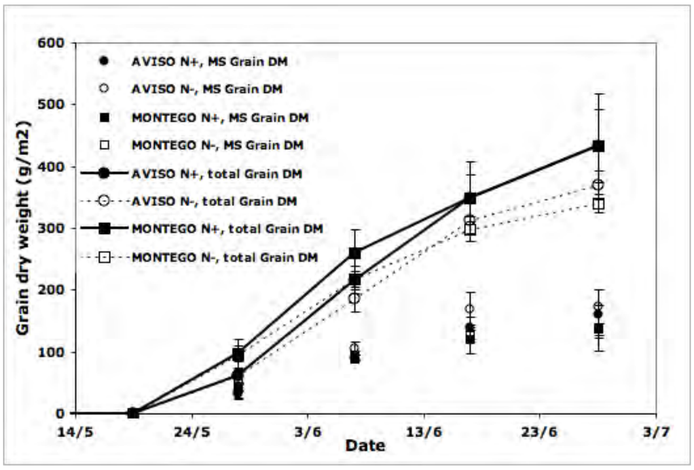

Figure 1 : Grain dry matter accumulation for the two genotypes (Aviso and Montego) under two nitrogen availability levels (N+ and N-). The grain DM originated from main stem (MS) or from the whole ramified system are separately represented.

a) At the harvest and for each genotype, TGW didn't depend on N availability (fig 2). Moreover, main stem and ramifications displayed the same global TGW. Ramification grain growth appeared to be delayed *versus* main stem, but main stem grain growth stopped before ramification grain growth, probably due to reduced pod photosynthesis. The two genotypes studied differed by grain growth earliness, and their TGW level at harvest, respectively 4,7g for Aviso and 4,1g for Montego.

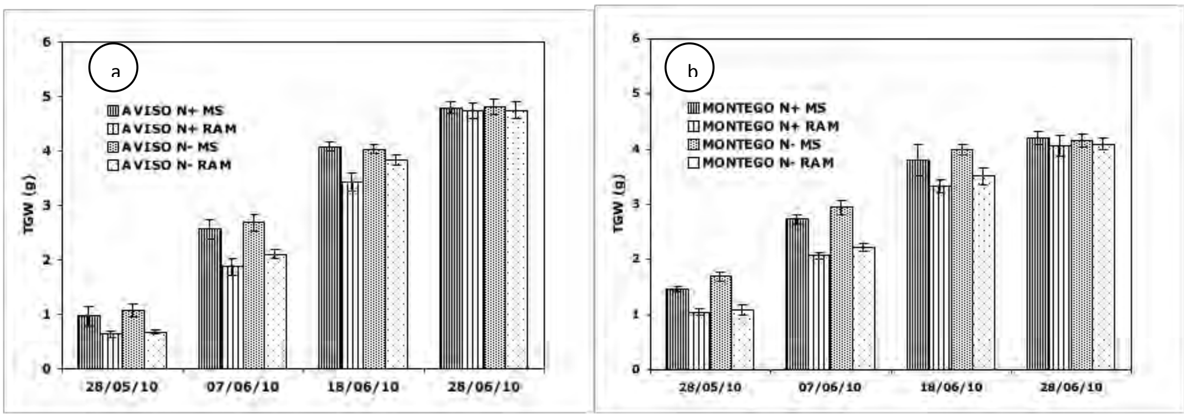

Figure 2 : Thousand grain weight (TGW) dynamics for the two genotypes Aviso (a) and Montego (b) under two nitrogen availability levels (N+ and N-); main stem (MS) and ramifications (RAM) TGWs are represented separately.

b) The number of grains (Gn) by soil surface unit was calculated for each type of axis (main stem and different first order ramifications) as the sum of the number of pods (Pn), multiplied by the number of grains *per* pod (Gnpp) :

$$Gn = \sum_{axes} Pn \times Gnpp$$

- Under classical sowing densities, first order ramification appearance concerns the buds located at the basis of main stem upper leaves; we consider here that second order ramifications were negligible. The number of ramifications *per* plant is established at the beginning of flowering, with respect of earliness differences (figure 3). Despite a great variability at the plant level, the number of ramifications for the two genotypes was always higher at high nitrogen availability. Conversely, plant density observed at each measurement date was always lower at high nitrogen availability, probably due to light competition increase (figure 4). As a consequence, the number of stems (main stem and ramifications) by square meter was constant for each genotype (table 1).

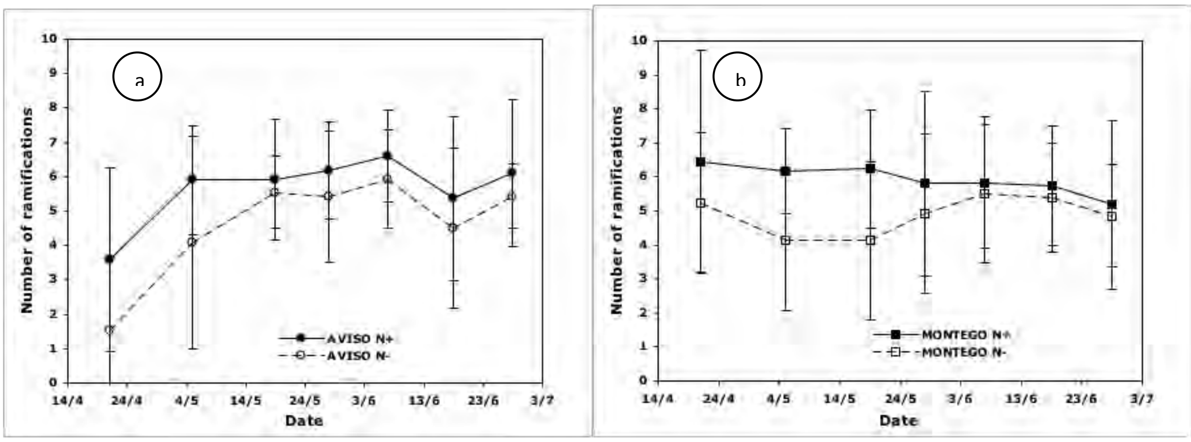

Figure 3 : Number of ramifications per plant for the two genotypes Aviso (a) and Montego (b) under two nitrogen availability levels (N+ and N-).

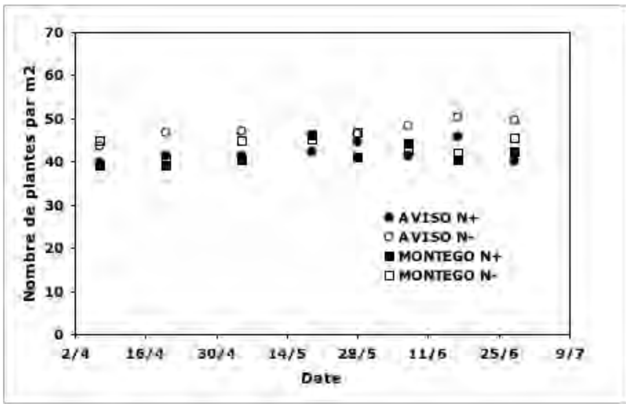

Figure 4 : Number of plants per square meter (density), for the two genotypes Aviso and Montego under two nitrogen availability levels (N+ and N-).

Genotype	**Nitrogen**	**Nb of axes *per* m2**
Aviso	N+	302,6 ± 17
Aviso	N+	307,2 ± 25
Montego	N-	278,9 ± 17,6
Montego	N-	278,4 ± 9

Table 1: Number of axes per square meter for for two genotypes under two Nitrogen availability levels (N+ and N-

- At harvest time, the average pod number *per* axis followed the same pattern for all the treatments (figure 5). Lower nitrogen availability induced a reduction of the final number of pods for all the axes. This reduction was amplified for the basal axes, and was directly linked to the reduction of axis final length (fig 6).

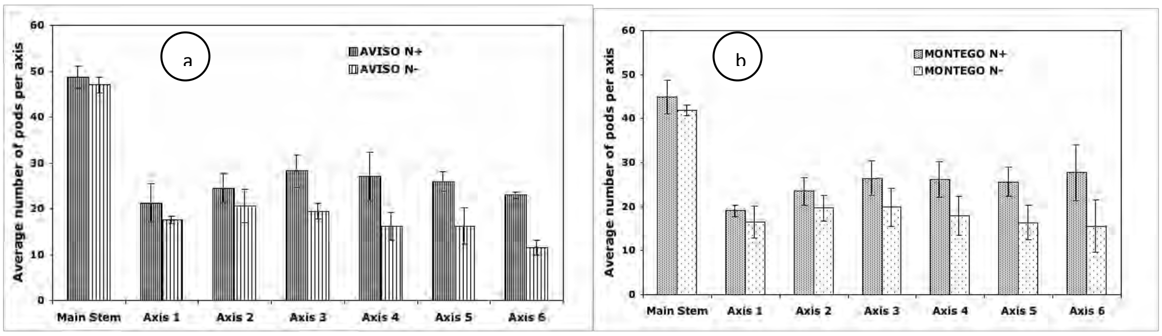

Figure 5 : Average number of pods per ramification for the two genotypes Aviso (a) and Montego (b) under two nitrogen availability levels (N+ and N-). First order axes were top-down identified from 1 to 6.

-Grain number *per* pod (Gnpp) had not been directly measured, but can be assessed by dividing axis grain mass by the number of pods present on this axis. When represented *versus* grain growth (TGW) for he main stem, this ratio remains constant (fig 7), but lower than expected values, probably due to the fact that the number of pods included empty or not fully filled pods on each axis.

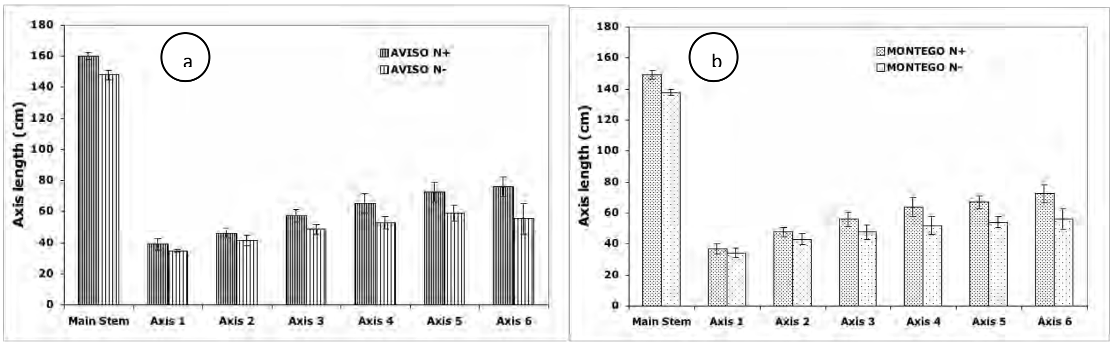

Figure 6 : Average axis length for the two genotypes Aviso (a) and Montego (b) under two nitrogen availability levels (N+ and N-). First order axes were top-down identified from 1 to 6.

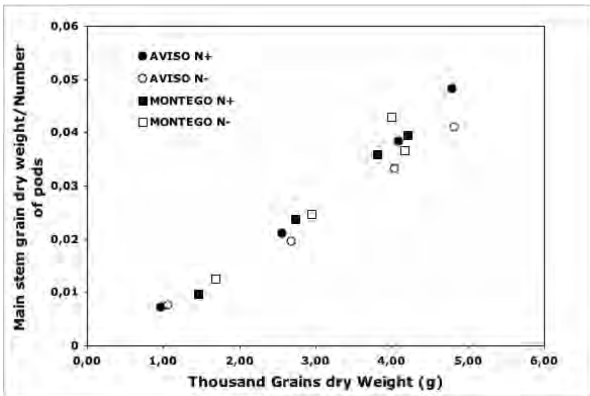

Figure 7: Main Stem grain DW per pod *versus* TGW, for the two genotypes Aviso and Montego under two nitrogen availability levels (N+ and N-).

Discussion

Under usual agronomic practices and for conventional genotypes, we showed that oilseed rape grain yield partly relies on branching and branches characteristics. The number of pods *per* plant is related for each genotype to the growth of all the different axes allowed by nitrogen availability, while first order axes dynamics, even if dependant on genotype earliness seems to be at the canopy level regulated by light availability. Otherwise ramification grain growth is delayed *versus* main stem, but at harvest, Thousand Grain

Weight is both independent of the type of ramification and nitrogen availability, and mainly genotype dependant.

Nitrogen availability during reproductive period relies only weakly on the nitrogen uptake from soil, but mainly to nitrogen remobilisation from leaves and stems. As a result, we can hypothesize that plant nitrogen content at the beginning of reproductive period could be a good indicator of the potential number and surface of pods.

Conclusion

It appears that architectural analysis during reproductive period, including branching intensity and pod setting on each branch, is a promising way to understand genotype x nitrogen interactions. In this context, accurate knowledge of branching and pod setting dependence on environmental conditions and genotype is needed, in order to both improve architectural modelling and to design efficient oilseed rape ideotypes. Moreover, this effort has to be linked to current studies on oilseed rape plasticity, which allows to maintain pod number after floral buds destruction resulting from insect damages (Pinet, 2010).

References

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