Winter rapeseed oil content variability at an agricultural cooperative supplying area scale

Luc Champolivier[1], Jérôme Thibierge[2], Jean-Marie Larcher[3], Etienne Pilorgé[1]

[1] *Cetiom, Centre de Grignon, B.P. 4, 78850 Thiverval-Grignon France.*
Email: champolivier@cetiom.fr, pilorge@cetiom.fr
[2] *Invivo, 83-85 avenue de la Grande Armée, 75782 Paris France. Cedex 16. Email: jthibierge@invivo-group.com*
[3] *Epis.Centre, service technique, Le Chaumoy, 18570 Le Subdray. France. Email: jml@episcentre.com*

Abstract

The crushing sector pays the agricultural cooperatives for winter rapeseeds in relation with their oil content. The aim of this study was to understand the main variation factors in oil content at the scale of a grain supplying area, in order to elaborate strategies to increase the mean oilseed content of the storage receipt. Experimental data are available from a network of about 70 fields of rapeseed set each year in 2003 and 2004 in the centre of France. The fields were spread over the whole supplying area. The main soil types and crop management of this area were represented. The study focused on 4 varieties, among the most cultivated. The main characteristics of the soil and of the crop management were collected for each field. The yield, thousand seed weight, oil content and protein content of the harvested seeds were measured. The results showed that the seed oil content variability was high : from 43 to 52 % of the dry matter. The main factors influencing the oil content were the soil type (particularly the soil depth and the water capacity), the variety (but the varieties with high oil content levels were not always the most productive), and the N balance (the higher the excess of N fertilization, the lower the oil content). The strategy of the agricultural cooperatives in order to increase the mean oilseed content of their storage receipt is often to advise farmers to grow varieties with high oil content. This study showed that a better adjustment of the N fertilization is also an interesting strategy. Indeed, even if important progress has been made over the past few years, many fields are still overfertilized.

Key words : rapeseed, oil content, variability, supplying area

Introduction

The crushing sector is highly interested in receiving rapeseeds with high oil content and therefore pays agricultural cooperatives according to the seed oil content. Agricultural cooperatives are looking for crop management techniques which will produce seeds with higher oil content. In order to achieve this, it is important to identify the main variation factors in oil contents and yields at the scale of a supplying area, and to quantify their effects.

The aim of this communication is to present such an analysis carried out in collaboration between the agricultural cooperative Epis.Centre, the union of cooperatives Invivo and Cetiom.

Materials and methods

We studied the production area of the agricultural cooperative Epis Centre, located in the centre of France (departments of Indre, Cher and Nièvre).

In 2003 and 2004, agronomic surveys were carried out within the Opticoop web (Invivo), on a sample of farmers and fields determined by the agricultural cooperative. Requested information concerned essentially the location, the variety, the soil type (name, depth and maximum soil water reserve –SWR-), the conditions of crop establishment (sowing date, spacing between rows, seed density…), the weight of above fresh matter (Farmstar-Rapeseed source), the fertilization (nature of manure, dates and doses), crop protection (chemical, dates, doses) and the yield. The plots were distributed within the global supply area of the cooperative. The study has been deliberately restricted to 4 varieties among the most cultivated in this region : Aviso, Banjo, Kosto and Pollen (the latter in 2003 only). Seed samples collected at harvest were studied to obtain the thousand seed weights, the oil contents by NMR (NF EN ISO 10565) and the protein contents (Dumas method : NF V18-120) at the seed analysis laboratory of CETIOM.

We obtained all requested agronomic information and samples on 63 plots in 2003 and 77 plots in 2004. The results were firstly exploited on a descriptive way : distribution of seed yields and oil contents for each environmental elementary factor or farming management technique having a potential effect on them.

A more detailed analysis was then carried out on nitrogen nutrition : simplified calculation of nitrogen assessment *a posteriori* and so, of nitrogen excess or deficit for the crop. The yields were expressed in t/ha and the oil contents in % of seed weight, for seeds at 0% of humidity and 0% of impurities.

Results and discussion

In all plots, the mean of oil contents presented little variation between the two years : 47.4 % in 2003 and 47.8 % in 2004 (table 1). However, the amplitude between the extreme contents was more important in 2004 (9.3 units) than in 2003 (5.7 units). The minimum content was smaller and the maximum content higher in 2004 than in 2003.

The mean yield was almost the same for both years : about 3.05 t/ha. The difference between the maximum and the minimum yields was about 1.6 t/ha in 2003 and 2.0 t/ha in 2004.

Table 1 : Variability in oil contents (%DM) and yields (t DM /ha) on all fields studied in 2003 and 2004 (n = number of fields ; min : minimum ; p25 : 1st quartile ; p75 : 3rd quartile ; max : maximum ; std : standard deviation)

	Year	n	min	p25	median	mean	p75	max	std
Oil content	2003	63	44.8	46.4	47.4	47.4	48.4	50.5	1.3
	2004	77	43.2	46.6	47.6	47.8	49.0	52.4	1.9
Yield	2003	63	2.21	2.76	3.08	3.05	3.30	3.83	0.4
	2004	77	2.05	2.85	3.06	3.06	3.39	4.01	0.4

There was no obvious direct relationship between the yield and the oil content (figure 1). Even if environmental conditions and cropping techniques allowed to reach a high level of yield, it was not sufficient to maximize the oil content. There were other specific factors which influence the oil content.

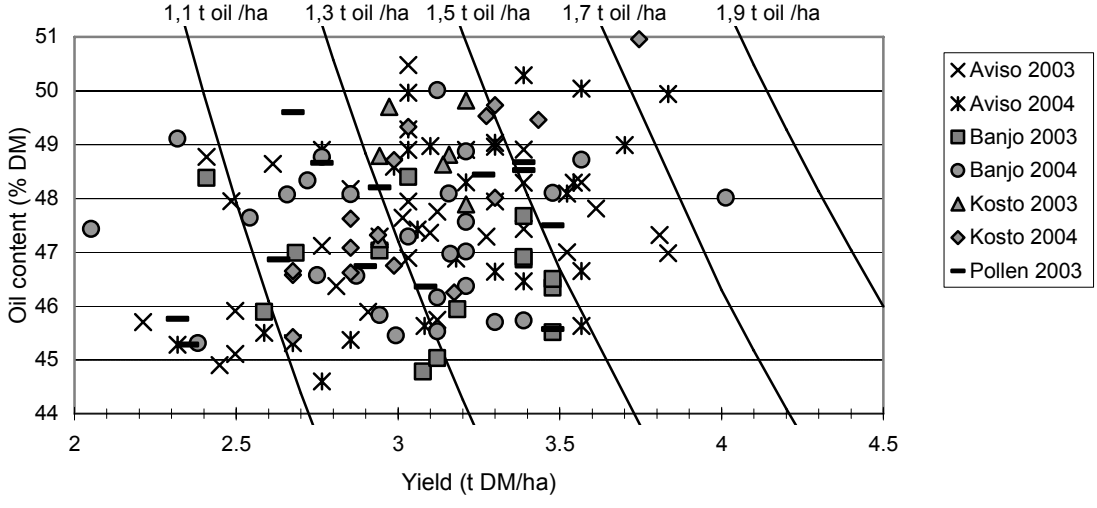

Figure 1: Relation between the yield and the oil content

The variety ranking was about the same between both studied years. The variety Kosto had the highest oil contents among the four studied varieties (table 2).

Table 2 : Effect of the variety on the variability of the oil content in 2003 and 2004 (n = number of fields ; min : minimum ; p25 : 1st quartile ; p75 : 3rd quartile ; max : maximum ; std : standard deviation)

Year	Variety	n	min	p25	median	mean	p75	max	std
2003	Pollen	13	45.3	46.4	47.5	47.4	48.5	49.6	1.4
	Aviso	29	44.9	46.9	47.4	47.4	48.2	50.5	1.3
	Banjo	14	44.8	45.9	46.7	46.6	47.0	48.4	1.1
	Kosto	7	47.2	47.9	48.8	48.7	49.7	49.8	0.9
2004	Aviso	29	43.2	45.6	48.1	47.5	49.0	50.3	1.9
	Banjo	29	45.3	46.4	47.6	47.6	48.3	52.4	1.7
	Kosto	19	45.4	46.7	48.0	48.5	49.7	52.2	2.0

This point influenced the mean in 2003 and the top part of the values distribution in 2004 (p75). Nevertheless it is useful to notice its low number of fields in 2003. The varieties Pollen and Aviso showed close oil contents and slightly lower than Kosto. Lastly, Banjo was the poorest variety in oil in 2003 and in 2004. Among the studied varieties, the difference in oil contents between the extreme values was 2.7 units in 2003 and only 1.4 units in 2004, concerning the third quartile.

Within a same variety, the amplitude of oil contents between plots went from 2.6 units for Kosto (7 plots only) in 2003 to 7.1 units for Aviso and Banjo in 2004. The intra-varietal variability was higher in 2004 than in 2003. It was also clearly higher than the variability between varieties, which pointed out the importance of growing conditions on oil content. Nevertheless we will add that varieties cultivated in this production area had already been chosen by the agricultural cooperative among varieties rich in oil, which limits the observed varietal effect.

We chose to study the effect of the soil type using the maximum soil water reserve as indicator. Figure 2 presents the results obtained in 2003, year that was characterised by an intense spring drought in France, particularly during flowering. As expected, the median yield in superficial soils (SWR < 60 mm) was 3.9 q/ha lower compared to the deep soils. Moreover, the

yield variability is quite lower in deep soils than in superficial soils. Despite these high differences in yields, there was no difference linked to the soil type concerning the oil content.

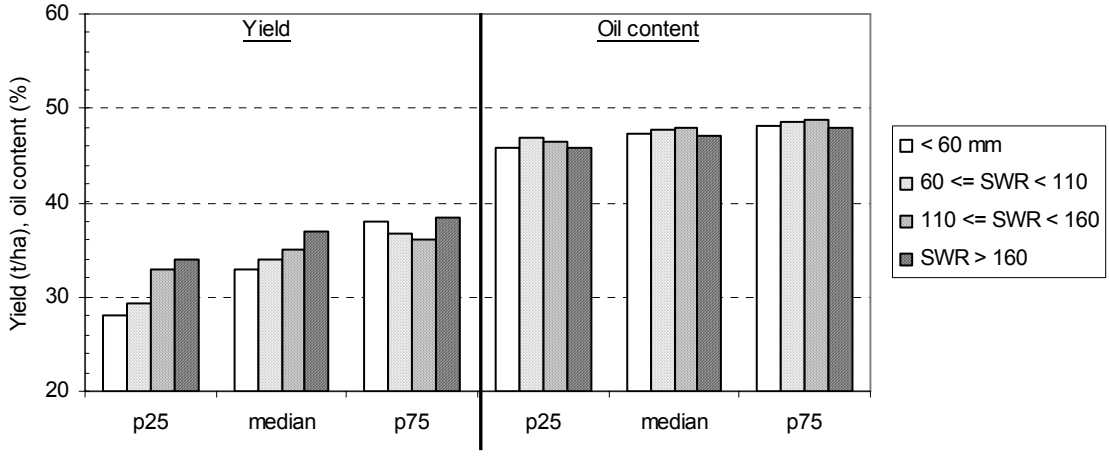

Figure 2 : Effect of the maximal water soil reserve (SWR) on the yield and on the oil content (2003)

Among studied factors of crop management, nitrogen fertilization proved to be one of the most important concerning oil content. The calculation of nitrogen fertilization requirement was realised on each plot using the obtained yield, the amount of absorbed nitrogen in the plants at the end of winter, a predicted mineralization of soil organic nitrogen (humus, residues of last crop, organic manure) depending on EPICLES fertilization plan developed by Invivo. This assessment allowed us to calculate the optimal rate of mineral fertilization in spring. This rate was compared to the rate really applied by farmers on each field of a single variety. It appeared that the oil content seemed to decrease when the fertilization exceeded the optimal rate advised by EPICLES by more than 20 to 30 kgN/ha, as shown in figure 3 for the variety Aviso. The decreasing effect of nitrogen excess on oil content (about 2 units of oil content decrease for an excess of 50 kg N/ha) was nevertheless probably overestimated. Indeed, this decreasing tendency has also been pointed out in a network of trials managed by Cetiom, but with a quite weaker slope (about 0.5 unit of oil content decrease for 50 kgN/ha of nitrogen excess).

The results presented in this paper come from a survey carried out into farmers' plots. This system does not allow to study the effects of the different environmental factors and crop growing management factors in an independent way.

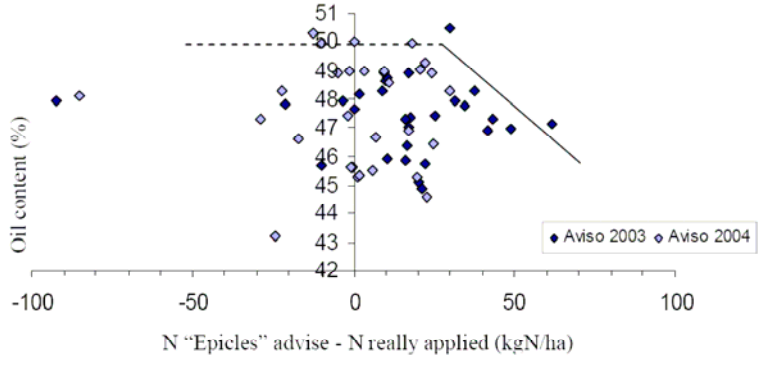

Figure 3 : Effect of the over-fertilization on the oil content (variety Aviso, 2003 and 2004)

Conclusion

This study offered the advantage of representing the reality of oil content variability at the scale of a production area, in real conditions of agricultural production.

The results showed that the strategy of variety choice which is often preferred by agricultural cooperatives to improve oil content of collected seeds is not the only one to carry out. Moreover, it seems important to take care of other farming controls, in particular nitrogen fertilization, because an excess of fertilization can cost until several units of oil. This is even more true in an area where rapeseeds yields are irregular, so the over-fertilization is frequent, mainly in soils where potential yields may be low.