# A PREVISIONAL NITROGEN BALANCE METHOD FOR WINTER RAPESEED SPRING FERTILIZATION

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## ABSTRACT

In order to improve the nitrogen fertilization on winter rapeseed, a nitrogen balance sheet was adapted to rapeseed crop specificity : high growth before winter due to early sowing dates. In 1994, field experiments demonstrated the effect of rape nitrogen content late in winter on spring nitrogen fertilizer requirements. Including this last result, a previsional nitrogen balance method was tested in 28 field trials.

## INTRODUCTION

In France, there is a wide spread of optimum spring nitrogen rates. In order to forecast it, the wheat nitrogen balance sheet had been applied to rapeseed, unsuccessfully (Pouzet, 1985). Since then, several authors showed the importance of rapeseed state late in winter on the yield response to spring nitrogen rates : leaf area index (Fabre, Crozat, 1985), vigour index (Pouzet,1989) and nitrogen content (Reau, 1994). Consequently, we have studied a nitrogen balance sheet including rape nitrogen contents late in winter. This paper presents the results of these trials carried out in 1994.

## METHODS AND EXPERIMENTAL DESIGNS

With the nitrogen balance sheet tested, we considered that the apparent utilization rate of nitrogen fertilizer was unvariable with optimal or suboptimal fertilization. This utilization was calculated from the difference between the total nitrogen uptake and spring nitrogen fertilizer (Nf) and the total nitrogen uptake at nil nitrogen rate (No). It is considered that the additional nitrogen uptake (Nf - No) is proportional to spring nitrogen rate (X), with a factor called CAU, Apparent Utilization Coefficient (de Wit, 1953). A given amount of the total uptake without fertilizer (No) has already been absorbed late in winter (Nh). The other part, Np, will be supplied by the soil mineral nitrogen level late in winter or from the spring nitrogen mineralization. Thus, the total spring nitrogen rate was calculated from the following formula :
$Nf = Nh + Np + CAU.X$ .

The effect of Nh was tested in one site (Indre) in 1993-1994. In order to obtain different growth stages, we applied three autumn crop management techniques (first factor) : early sowing date (30 August) with 80 kg N/ha seed bed nitrogen fertilizer (No 1), early sowing date (30 August) without seed bed nitrogen fertilizer (No 2), and late sowing date (20 September) without seed bed nitrogen fertilizer (No 3). The first factor was associated to 5 spring nitrogen treatments : 0, 160, 210, 260 or 310 kg N/ha. We used 4 replicates for each of the 15 factorial combinations

specifically randomised within a 4 block layout. The previsional nitrogen balance method was tested in 28 different sites located in several French areas in the 1993-94 season. Spring nitrogen treatments consisted of : 0, X-50, X, X+50 kg N/ha. In order to estimate X, Nf was considered equal to the yield (t/ha) multiplicated by 70, so that 70 kg N/ha are required to produce a ton of rapeseed. CAU was estimated equal to 80%. Nh was measured late in winter. Np was estimated from the results of total nitrogen uptake at nil nitrogen rate under similar conditions of soil and farming system.

Spring nitrogen was divided into 2 or 3 top-dressings. We used 4 replicates for each of the 4 treatments randomised within a 4 block layout. The nitrogen shoot content was measured late in winter (C1 stage) and after the end of flowering (G4 stage). The total nitrogen uptake was estimated considering that the nitrogen root content reached 1:2 of the shoot nitrogen content at C1 stage and 1:4 at G4 stage. Spring nitrogen optima were calculated from the statistic yield response : the lowest rate with a yield from the variance analysis A group. The gross margin was calculated with a 1200 F/t rapeseed and a 3 F/kg nitrogen fertilizer.

## RESULTS

### Yield response versus nitrogen content late in winter

Yield responses to spring nitrogen are shown in Fig. 1, for the three fall crop management techniques. Late in winter, the above-ground nitrogen content was different between the three fall crop management techniques : 41, 21 and 9 kg N/ha respectively for methods No 1, 2 and 3. Each of the three different rapeseed crops had been able to reach the maximum yield provided the spring nitrogen rate had been sufficient. The higher the nitrogen content late in winter, the higher the yield at nil rate and the lower the optimum spring nitrogen rate.

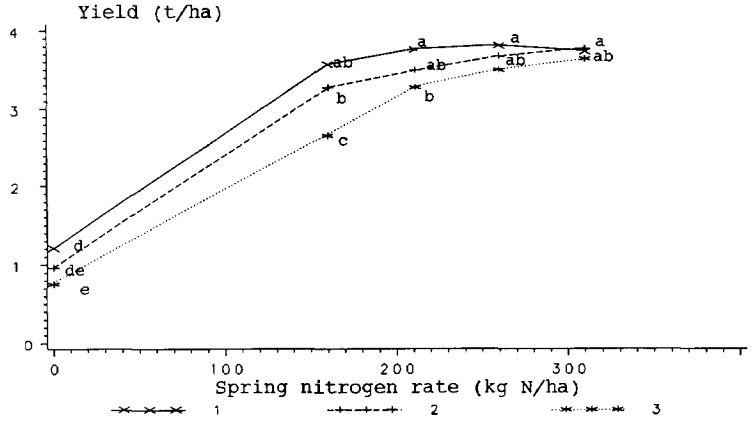


Figure 1. Yield responses to spring nitrogen rate versus three fall crop managements.

Test of a previsional nitrogen balance method

Our previsional estimation of optimum nitrogen rates ranged from 90 to 260 kg N/ha. Real optimum nitrogen rates ranged from 0 to 280 kg N/ha. In the 28 different sites, 4 optimum rates were under 100 kg N/ha, 12 between 150 and 200 kg N/ha, and 12 over 200 kg N/ha. Our prevision of optimum nitrogen rates was correct for 6 experiments. The optimum nitrogen rate was over the prevision for 7 sites, and under for 15 sites. However, the difference of yield between optimum rate and X rate was over 0.3 T/ha only for 4 trials. The gross margin at previsional optimum spring rate was compared to the gross margin of a "standard" spring nitrogen rate (between 151 and 200 kg N/ha). The previsional nitrogen balance method was economically more efficient than the "standard" rate, with a mean gross margin increase of 112 F/ha for the 28 experiments. The benefit came from higher yields when more than 200 kg N/ha was required, as well as from a fertilizer cost reduction without yield reductions when less than 150 kg N/ha was required.

## DISCUSSION

The main result of these 1994 experiments is the experimental proof of rape winter nitrogen content effect on yield response and optimum spring nitrogen rate removing. The higher the nitrogen content late in winter, the lower the optimum spring nitrogen rate. Now, we can explain the failure of the application of the nitrogen balance sheet from wheat to rapeseed : the nitrogen content late in winter cannot be neglected for the rapeseed nitrogen balance sheet. Indeed, among the 28 trials, the total nitrogen content ranged from 8 to 152 kg N/ha. Although the previsional balance method gave better economic results than the "standard" fertilization, it often led to an overestimation of the optimum spring nitrogen rate. The data analysis showed that the main reasons for this overestimation were : i) nitrogen uptake necessary and sufficient to produce a ton of rapeseed, at optimum rate, total nitrogen was often below 70 kg N/t ; ii) CAU rose frequently above 80% especially with high growth late in winter ; iii) important nitrogen uptake at nil rate, which ranged from 0 to 176 kg N/ha.

## REFERENCES

de Wit, C.T. (1953). A physical theory on placement of fertilizers. *Versl. Land-bouwk. Onderz. Agri. Res. Rep.*, 59(4), 71p.

Fabre, A., Crozat, Y. (1985). Approche méthodologique de l'étude des courbes de réponses du colza à la fertilisation azotée. *Informations techniques* Ed CETIOM, Paris, 90, 3-12.

Pouzet, A. (1985). Raisonnement de la fertilisation azotée du colza d'hiver en France.In *Bulletin GCIRC*, 62-68.

Pouzet, A. (1989). La fertilisation azotée. In *Cahiers techniques Colza* Ed. CETIOM, Paris, 18-27.

Reau, R., Wagner, D. and Palleau, J.P. (1994). End of winter diagnosis : winter rapeseed (Brassica napus) and nitrogen fertilisation. *Proceedings of the third congress of the European Society for Agronomy*, 220-221.