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Studies on nitrogen rates, sowing dates and cultivars of rapeseed in North-eastern Portugal

M. Ângelo Rodrigues (1,2), Lino Maia (2), Rodrigo Rocha (2), Isabel Q. Ferreira (2), Margarida Arrobas (1,2), Arlindo Almeida (1,2)

(1) Mountain Research Centre – (2) Polytechnic Institute of Bragança
Phone: 00351 273303237; E-mail: angelor@ipb.pt

1. Introduction – The rapeseed production in the world has more than doubled in the last twenty years. Total world production increased from 26.7 x 10^6 in 1992 to 62.5 x 10^6 in 2011 [1]. The increase in rapeseed production has been stimulated by the improved quality of the oil for human consumption, but also due to the increased demand for the production of biodiesel. Rapeseed production is widespread in cold temperate European countries. However, in the Mediterranean basin the crop may experience severe water stress during the spring months, reducing the yield potential of the crop and consequently its profitability. In Portugal the cultivation of rapeseed was not yet adopted by the farmers, although some studies had been carried out to assess the environmental suitability for growing this crop [2,3]. In this work we report results of new experiments where different nitrogen rates, sowing dates and cultivars were tested.

2. Experimental – Two field trials with rapeseed were carried out in Bragança (NE Portugal) in the growing season of October 2011 – July 2012. The climate of the region is of Mediterranean type with some Atlantic influence. Monthly minimum and maximum temperature and precipitation recorded during the experimental period and in the period 1971-2000 were presented in figure 1. The experiments were installed in an Alisol, loamy textured, acidic (pH_{H2O} 4.6), low in organic matter (0.93%) and medium and high levels of phosphorus and potassium, respectively.

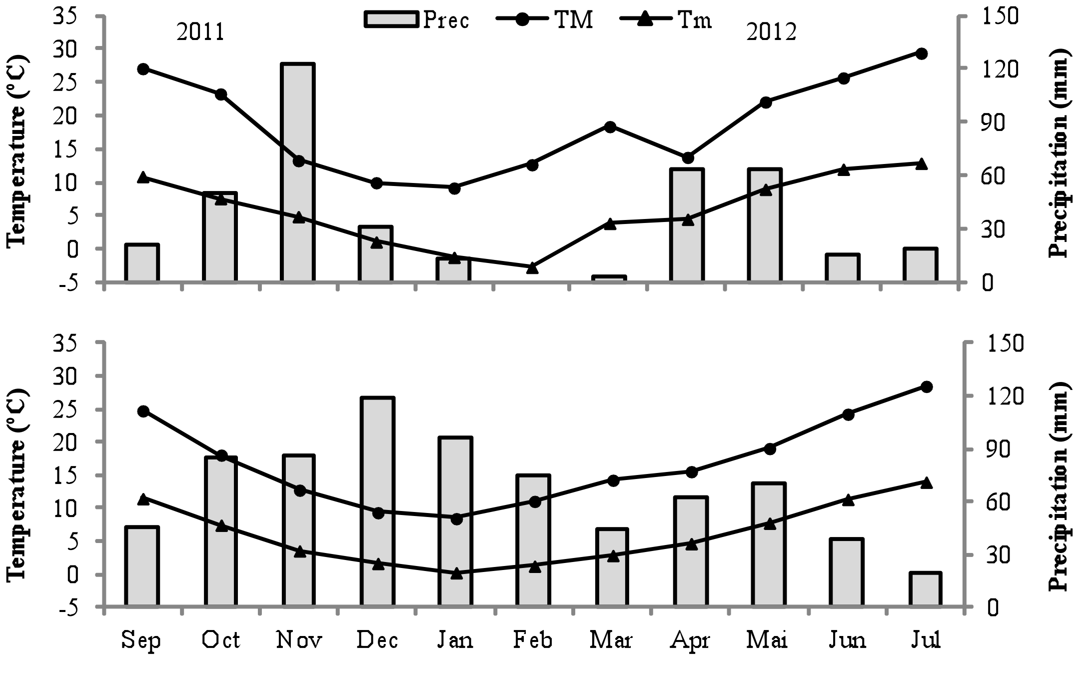

Figure 1. Maximum (TM) and minimum (Tm) temperature and monthly precipitation (Prec) during the experimental period (top) and average values for the period 1971-2000 (bottom).

In one of the experiments, we compared different cultivars and sowing dates. The cvs. used were Hydromel, Williams and Jura. Hydromel was sown in two dates (October 31st and November 25th, 2011). Williams and Jura were sown in October 31st 2011 and March 5th 2012. Devrinol (napropamide) was used as a residual herbicide applied before sowing. Sowing was performed with a small-seeds drill. The seeds were placed at approximately 2 cm depth and used in a rate of 4 kg seed ha^{-1}. Lime (2000 kg ha^{-1}), phosphorus (40 kg P_2O_5 ha^{-1}) and potassium (40 kg K_2O ha^{-1}) were applied before sowing based on soil analysis and laboratory recommendation. Data recorded were plant density, plant phenology dynamic, ground-cover percentage, seed and total biomass yield, N concentration in seed and straw and N recovered in seed and in straw. In the second experiment the cv. used was Hydromel. In this experiment we planned to apply several N rates at pre-plant and top-dress. However, the growing season was unusually dry. The accumulated precipitation in December, January, February and March was 47 mm, whereas the average of the region (1971-2000) for those four months is 334 mm. In late February of 2012 the crop seemed to be completely lost. The rosette was really insignificant and the plants had started the stem elongation phase. Thus, it was decided do not establish the top-dress N treatments. The final N treatments in this experiment were 0, 25 and 50 kg N ha^{-1}, such as they were established at pre-plant.

3. Results and Discussion – The emergences of the first seeding (October, 31st) can be considered normal for cv. Hydromel (figure 2). The plant density one month after sowing was 48.3 plants m^{-2}. Cv. Williams showed an acceptable mean value, in spite of have showed great spatial variability. Seedling emergence in Jura was very poor, with a mean value of 20.7 plants m^{-2}. The optimal plant density is usually considered between 40 to 60 plants m^{-2} [4]. The lack of precipitation in the period following seeding and the drop in temperature may justify the poor emergence rate of cv. Jura. The emergences in the second date of sowing in the autumn (Hydromel) and in late winter (Williams) were particularly poor, with less than 10 plants m^{-2}. The emergence of Jura sown late in winter was nil.

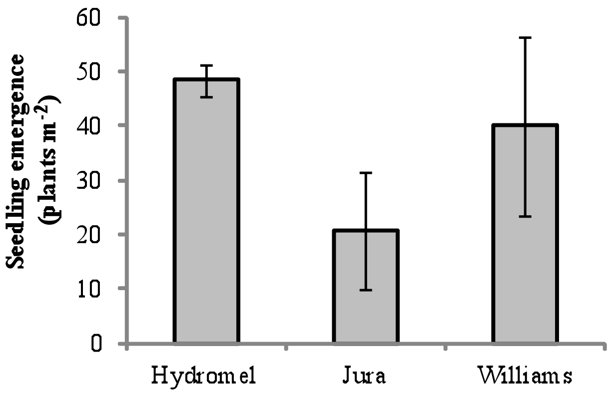

Figure 2. Seedling emergence for the three cultivars sowed in October 31st, 2011.

The growth of the crop in the autumn was very low. In spring the plants initiated the development of their inflorescence without having significant reserves in the rosette. In March 19th, the ground-cover percentage varied from 5 to 15 % (figure 3). In May 15th, at 60 to 80% of potential pods in the raceme longer than 2 cm, the ground-cover percentage was lower than 40% for all cultivars. The canopy never reached a significant leaf area index. The accumulated precipitation during December, January, February and March was 37 mm whereas the normal precipitation rate for these four months is 334 mm. This winter was the driest in several decades of meteorological records in the region.

Hydromel presents a longer growing cycle than Williams and Jura. Consequently, there was found a delay in their phonological phases from March to April (Table 1). After April, the phonological stages have become difficult to identify using the scale of Mendham and Salisbury [5], since all the flowers in the terminal raceme suffered abortion due to the severe drought. The first pods appeared in lateral branches.

The mean seed yields in the fertilization trial were not statistically different among the pre-plant N treatments. The values ranged between 949 and 1178 kg ha^{-1} (Table 2). Jura and Williams cvs. sown early in the autumn produced an amount of seed not significantly different than the cv. Hydromel. The yields of Williams sown in March and Hydromel sown in November were very low, with average seed yields of 212 and 369 kg ha^{-1}, respectively. In previous studies in this region there were obtained markedly different rapeseed yields in different years, depending mainly of the precipitation of the winter and spring months [2,3].

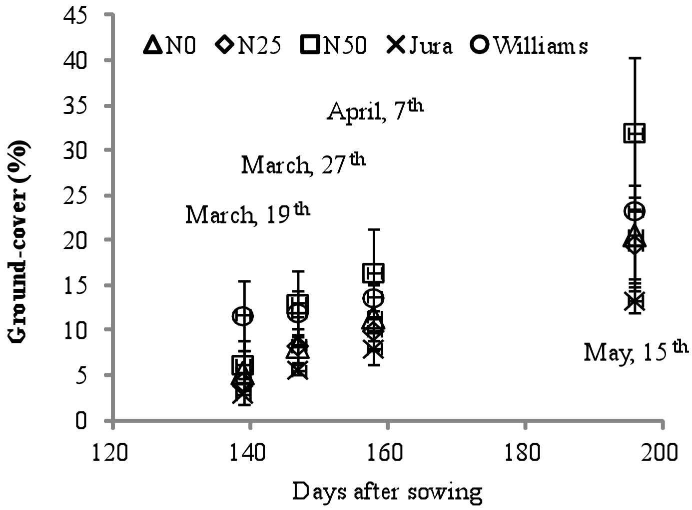

Figure 3. Ground-cover percentage over the growing season in the Hydromel plots subjected to different N rates and in those grown with Jura and Williams sown in October 31st.

Table 1. Phenological stages of the rapeseed cultivars sowed at October 31st and November 25th (date 2).

Cultivar	March,19th	March, 27th	April, 7th	April, 23th	May, 14th
Hydromel	3.0	3.1	3.7	5.0	5.8
Jura	3.1	3.9	4.2	5.0	5.8
Williams	3.3	3.9	4.2	5.0	5.8
Hydromel, date 2				3.1	5.6

3.0 – Only leaf buds present; 3.1 – Flower buds present but enclosed by leaves; 3.7 – First flower buds yellow (yellow bud); 3.9 – More than half flower buds on raceme yellow; 4.2 – 20% of all bud on raceme flowering or flowered; 5.0 – All visible buds on terminal raceme finished flowering; 5.6 and 5.8 – 60% and 80%, respectively, potential pods on raceme more than 2 cm long.

Table 2. Dry matter yield and N recovery at harvest time in straw and seed for the different rapeseed cultivars (Hydromel, Williams and Jura), pre-plant N rates (0, 25 and 50 kg N ha^{-1}) and different dates of sowing (Oct 31st, Nov 25th, Mar 5th).

		Dry matter yield (kg ha^{-1})			N recovery (kg ha^{-1})		
Treatment		Straw	Seed	Total	Straw	Seed	Total
Hydromel	N0	4907±934	949±447	5856±1004	22.1±6.6	31.2±7.2	53.3±8.9
	N25	4372±469	1128±211	5500±577	17.5±3.7	34.1±7.8	51.6±9.8
	N50	5486±650	1178±552	6664±937	23.6±6.6	39.7±22.0	63.3±22.8
	Date 2	2542±526	369±19	2911±538	13.0±3.2	13.3±0.5	26.2±3.5
Williams	Winter	5110±715	1000±181	6111±816	21.5±5.9	35.0±7.2	56.5±10.8
Jura	Winter	4320±499	1002±22	5322±514	12.5±1.2	33.8±2.3	46.3±3.0
Williams	Spring	1354±387	212±17	1748±374	8.9±6.3	8.1±0.1	17.0±6.4
Jura	Spring	---	---	---	---	---	---

In the present study, the unusual low precipitation levels in winter and early spring strongly compromised the possibility of obtaining higher seed yields. The lack of rain also did not allow a significant response of the crop to the different N rates, in spite of under regular environmental conditions rapeseed usually respond to N fertilization [6,7]. N recovery varied from 46.3 to 63.3 kg ha^{-1} in the plots sown in October 31st (table 2). The plants of the plots sown late in autumn (November, 25th) and late in winter (March, 5th) recovered, respectively, 26.2 and 17.0 kg N ha^{-1}.

Rapeseed stand appear with great spatial variability with small patches of higher crop growth. These patches seemed to be due to water accumulation of the scarce rains in slight depressions. A study initially not scheduled was carried out consisting on the determination of above-ground biomass in several points of the field, including patches of high and low crop growth. Soil samples were also collected to determine pF curves at 4.2, 2.7 and 2.0, having in mind that the water holding capacity may be different due to the accumulation of clay by soil erosion. The results did not showed a significant linear relationship between the two variables (figure 4), which may mean that the small depressions may have received some water but are not great enough to influence the soil fertility parameters.

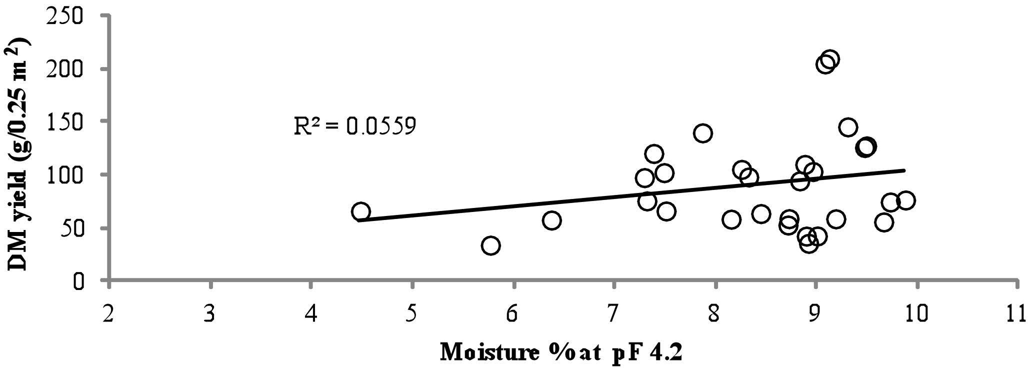

Figure 4. Relationship between total above-ground dry matter and pF 4.2.

4. Conclusions – The cultivation of rapeseed in NE Portugal seems to present a relatively high risk for farmers. The crop performance is greatly dependent of the precipitation of winter and early spring which in turn, in the Mediterranean basin, presents a high inter-annual variation.

5. References

[1] FAO (Food and Agriculture Organization of the United Nations) – Faostat production, crops (on line). Available in http://faostat.fao.org/site/567/default.aspx#ancor (access, February 28th 2013).

[2] M.A. Rodrigues, I.Q. Ferreira, M. Arrobas, Rev. Ciênc. Agrar. XXXIII (2), (2010) p. 27.

[3] M.A. Rodrigues, A.C.F. Almeida, J. Ribeiro, M. Arrobas, Proc. 4th International Congress on Energy and Environment Engineering and Management, Mérida, Spain, 2011.

[4] EURALIS, Rape-seed hybrids (on-line). Available from http://www.euralis-semences.fr/seeds/rubriquesd67c.html?id_rub=3&id_ssrub=7 (accessed may 31st, 2013).

[5] N.J. Mendham, P.A. Salisbury, In: D. Kimber, D.I. McGregor (eds). Brassica Oilseeds. Production and Utilization. CAB International, Wallingford, UK, p.11.

[6] H. Ozer, Eur. J. Agron. 19 (2003) p 453.

[7] G.-W. Rathke, T. Behrens, W., Diepenbrock, Agric., Ecosys. Environ. 117, (2006) p. 80.

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