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PRODUCTION OF SOME RAPESEED CULTIVARS UNDER DIFFERENT CLIMATIC CONDITIONS IN SLOVAKIA

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Abstract

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Production of six *Brassica napus* var. *napus*; syn: *Brassica napus* ssp. *oleifera* cultivars was studied in relationship to various climatic conditions. The production parameter estimated was seed production, while oil content, oil production and the substantial content of seed fatty acids were the qualitative parameters determined. Air temperature and atmospheric precipitation were considered to be the most important climatic factors in rapeseed production. The mean monthly values for these factors in 2007/2008 were compared with values established over the longer-term period of 1961 to 1990. It can be concluded from this data that the course of the weather was generally favourable for all important growth stages comprising ontogenetic development. These consisted of sowing, flowering and seed maturation. Rapeseed was sown in August 2007, when recorded air temperature and precipitation were both above normal. September and December experienced colder than usual temperatures plus above-normal precipitation, while the January and February winter months were abnormally warm with somewhat limited precipitation. The spring months before harvest experienced 1.5 to 2.5 °C above the average monthly temperature, while precipitation ranged from 75 to 164% of normal values. A high seed production was estimated for Oponent, Atlantic and ES Astrid cultivars, with Oponent having both high oil content and production. The content of the most important fatty acid, oleic acid, ranged from 60.02% in Labrador to 65.80% in Atlantic. Oponent also had a higher content of oleic acid with 62.12%. Seeds of all studied cultivars had a low content of linolenic acid at 8.33–9.59%, while erucic acid ranged from < 0.01 to 0.05%. These values correspond with EU standards. When all the studied quantitative and qualitative parameters were considered, the Czech Oponent cultivar appeared to be the most suitable for Slovak climate conditions.

Key words: *Brassica napus***,** climatic factors, cultivars, fatty acids, oil, seed production

Introduction

The properties of the rapeseed *Brassica napus* L. var. *napus*; syn: *Brassica napus* L. ssp. *oleifera* make it an economically viable agricultural crop (Tóth, Hudec, 2007). It has a large-scale utilization, mainly as food but also in pharmaceutical and chemical industries. Additionally, oil extrusions are important nourishing components of animal fodder, and this rapeseed has also been recently used as a technical plant for production of renewable biofuels, including FAMEs – **f**atty **a**cid **m**ethyl **e**sters and PPOs – **p**ure **p**lant **o**ils (Masarovičová et al., 2009a). This rapeseed species is not only currently a technical and melliferous plant, but this it is expected to soon become an exceedingly rewarding functional crop. With phytofortification biotechnology, it is possible to prepare functional food fortified by substances with high nutritional value (For detail, please see Masarovičová et al., 2009b**,** 2010)**.** The higher accumulation of toxic metals, especially of cadmium, in rapeseed roots and shoots, has also assigned it to the plant species group with great potential in phytoremediation technology (Masarovičová et al., 2009c). UVB radiation of 290–320 nm induces higher concentrations of flavonoids in rapeseed leaves. These substances have many health-promoting effects, including protection against heart, cancer, diabetes and eyesight diseases and also in inflammatory reactions and obesity control (Wilson et al., 2001). Therefore, the seed's productive yield and quality of fatty acid composition have been extensively studied. In our last paper devoted to this topic (Tatarková et al., 2010) we studied the production potential of six rapeseed genotypes in relationship to soil quality, with applied agro-technology and plant protection techniques. In this paper we have now investigated the production potential of those same rapeseed cultivars in relationship to various Slovak climate conditions. These tested cultivars represent the following 3 production regions; maize production region (MPR), rapeseed production region (RPR) and the potato production region (PPR).

Material and methods

The field experiment was instituted on August 27, 2007 at the Centre for Research of Crop Production's experimental area at Borovce, near Piešťany in Western Slovakia. The Borovce locality is part of the MPR and it is situated at an altitude of 167 m a.s.l. The soil is Luvic Phaeozem (WRB 2006) formed from loess with a pH of 5.5 to 7.2, a humus content of 1.8 to 2%, and contents of adequate potassium, medium phosphorus and high magnesium.

The seeds of the 6 cultivars of rapeseed listed below were sown after the preceding crop of winter wheat, and these then underwent appropriate testing:

ES ASTRID (medium-early and low type cultivar, France, PPR)
ATLANTIC (medium-early and high type cultivar, France, PPR)
CALIFORNIUM (medium-early to early and medium-high type of cultivar, France, MPR)
LABRADOR (late and low to medium-high type of cultivar, France, RPR)
MANITOBA (late and medium-high type of cultivar, France, RPR)
OPONENT (late and high type of cultivar, Czech Republic, MPR).

Masarovičová et al. (2008a) published the characteristics of these above-mentioned cultivars in detail from the following aspects: resistance to lodging, resistance to low temperature damage, seed maturation, health condition and technical quality.

After the harvest of the preceding winter wheat crop, the soil was fertilized with 200 kg/ha (15:15:15) NPK, Trifluex 48 EC was applied to prevent weed growth and this was followed by Herbicide Busitan star and morphoregulator "Caramba" application. This stand was again fertilized in spring with 200 kg/ha, containing 23% N, 31% SO_3 and 3% MgO. This experiment was established in 25 experimental plots of 10 m^2, with 4 repetitions. The rapeseed harvest was reaped on July 11, 2008, and seed samples from all tested cultivars were retained for quantitative and qualitative analysis of seed oil, content and fatty acid composition. This analysis was performed in the accredited institution of the State Veterinary and Food Institute in Bratislava, in accordance with EU standards.

Results and discussion

From an agro-technical aspect, rapeseed is one of the most demanding crop (Surovčík, 2000). This species has exacting requirements, not only in soil quality, where it needs a high content of nutrients and humus, neutral soil reaction, microbiological activity and agro-technical provision of deep ploughing, preceding crop fertilization plus additional fertilizing,but it also needs appropriate climate conditions. Rapeseed generally prefers a moderate winter, a long growing season and a colder and more humid weather course [Please see Tatarková et al. (2010) for more detail]. This experimental rapeseed was sown in the Borovce locality in August 2007. It experienced a mean temperature of 20.7 °C and monthly precipitation of 93.6 mm, which can be characterized as warm and moderately humid weather conditions. September, October and November became increasingly colder with 12.8 to 8.6 to 2.8 °C, and precipitation decreased from 109 to 34 and 36 mm. December was mild and drier at -1.0 °C and 32 mm, but January and February 2008 were warmer and a little dry with 1.48 to 2.46 °C and 25.50 to 15.1 mm precipitation. In the successive months from March until the rapeseed harvest in July, temperatures increased from 4.73 to 11.07 to 16.84 to 21.16 and finally to 21.35 °C. Precipitation was favourable at 48, 31, 36, 66 and 89 mm. Fig. 1 lists the monthly mean temperatures for Borovce in 2007 and 2008, while Fig. 2 denotes the monthly precipitations there.

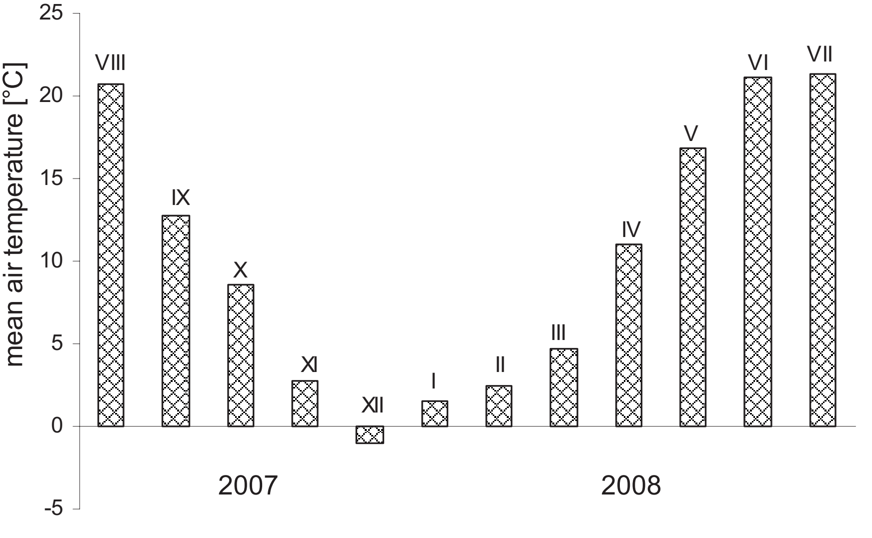

Fig. 1. Mean air temperature measured for locality Borovce for the years 2007 and 2008.

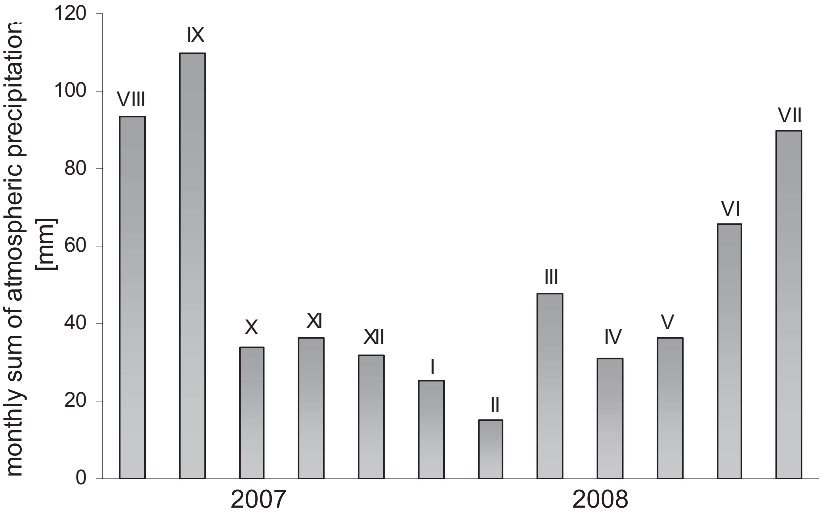

Fig. 2. Monthly sum of atmospheric precipitation measured for locality Borovce in the years 2007–2008.

It was discovered that the Californium cultivar had the lowest seed and oil production, as in yield, t/ha and % oil content. High seed yields were estimated for the Oponent, Atlantic and ES Astrid cultivars, and Oponent had both high oil content and oil production (Fig. 3). With respect to the important fatty acid methyl esters (FAMEs), oleic acid content ranged from 60.02% in Labrador to 62.12% in Oponent and 65.80% in the Atlantic cultivar (Fig. 4). The content of seed oil in all studied cultivars ranged from 41 to 48% which conforms with data published in the Company for Variety Composition and Breeding of "Česká řepka", 2008, where the value of this parameter for Oponent was 49%. Seeds of all studied cultivars had a low 8.33–9.59% content of linolenic acid which is important for oxidation stability in FAMEs, while the erucic acid content ranged from < 0.01 to 0.05% in all cultivars, again corresponding with EU standard values. Overall, Atlantic appears to be most suitable cultivar in this respect.

Baranyk and Málek (2009) tested 20 rapeseed cultivars for seed poduction, oil content and oil production. At their 3 tested localities of Bánovce n/Bebravou – RPR, Lúčnica nad Žitavou – MPR and Očová – PPR, these authors registered the following values for cultivars which were also tested at our Borovce locality; the seed production was 2.93–5.77 t. ha^{-1}, the oil content was 38.2–43.4% and the oil production was 1.24–2.54 t. ha^{-1}. It has also been established that colder localities provide higher seed oil content than warmer localities (e.g. Zukalová et al., 2006). Considering all studied quantitative and qualitative parameters, it was concluded that the Czech genotype Oponent cultivar is the most suitable for Slovak climate conditions.

As previously mentioned, Baranyk and Málek (2009) compared rapeseed production at three climatically different localities. Seed production at Lúčnica n/Žitavou (MPR) was

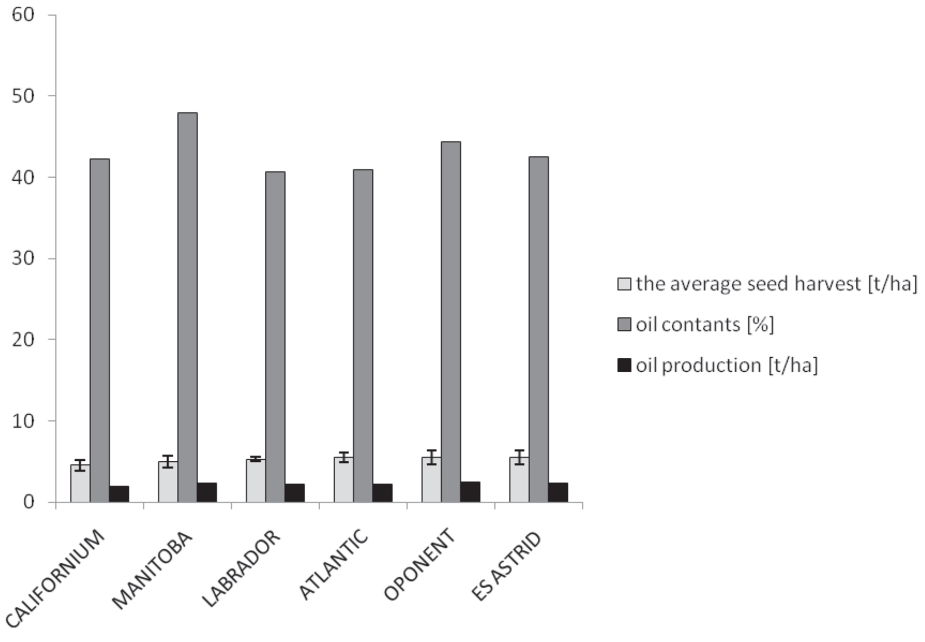

Fig. 3. Differences of some production parameters in studied rapeseed cultivars.

estimated for cv. Labrador at 5.72 t.ha^{-1}, cv. Oponent at 5.45 t.ha^{-1} and cv. Verona at 5.44 t.ha^{-1}. In our experiment, the seed productions for these cultivars was estimated at 5.29 t.ha^{-1}, 4.85 t.ha^{-1} and 5.08 t.ha^{-1}, respectively. (Fig. 3 highlights the MPR locality at Borovce). A record rapeseed yield of 5.72 t.ha^{-1} was estimated at Lúčnica n/Žitavou (MPR), despite near drought conditions in May and the beginning of June. According to the above authors, results at this locality confirmed that successful production occurred in these climate conditions with the assistance of appropriate agro-technical procedures. Additionally, Lúčnica n/Žitavou is a warmer region which contributed to a more rapid initiation of the generative phenophase in rapeseed cultivars. The complete course of flowering was earlier and longer here because of the sufficient precipitation and lower temperatures. It is also important in these experimental localities that spring frosts do not cause damage to plants or consequent fruit-fall. Therefore, favourable climate conditions are very important for rapeseed, because they certainly influence both seed production and oil content (Zukalová et al., 2006).

In addition to excessive cold and heavy frosts, the following factors also cause temperature damage to rapeseed stands; alternating low and high temperatures before spring and water-logged and decayed plants on wet soil during snow melts. Conversely, moderate wet and warm weather during sowing, flowering and seed maturation favours ideal rapeseed growth, while arid conditions negatively influence not only ontogenetical development of assimilation organs and seed formation, but also promote pathogenic processes. The most critical period for rapeseed cultivars is the end of the summer, when plant culture occurs.

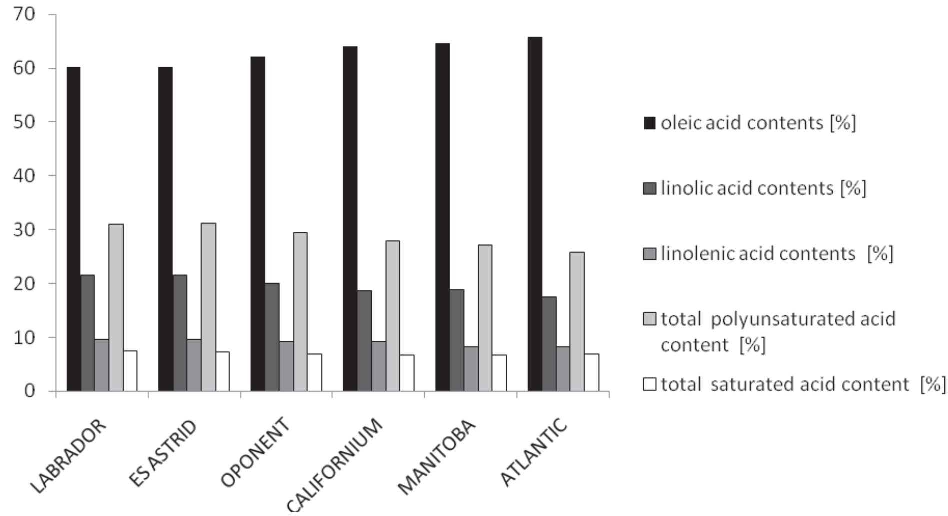

Fig. 4. Differences in the content and composition of fatty acids in rapeseed oil.

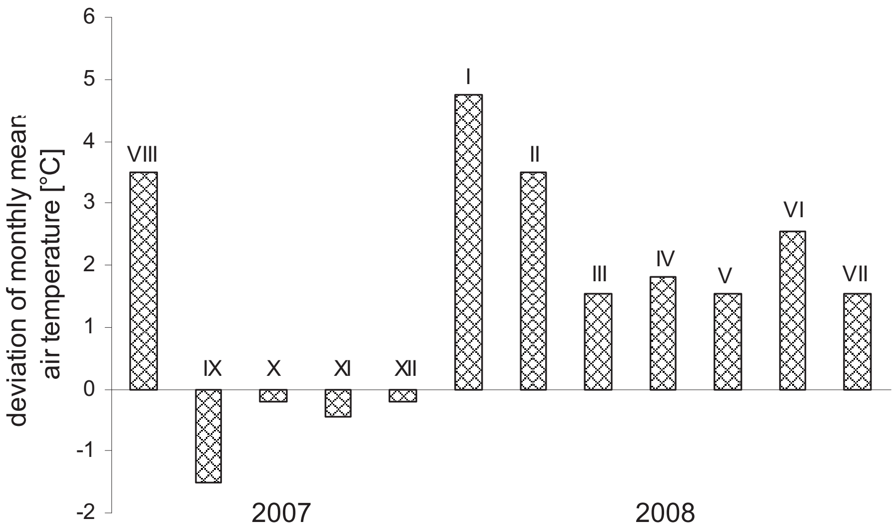

Fig. 5. Deviation of monthly mean air temperature measured for region of West Slovakia from monthly mean air temperature of normal values (period 1961–1990) for the years 2007 and 2008.

However, survival of the plants throughout the winter period with precipitation and snow cover leads to the expectation of high yields, while the ideal conditions mentioned above help to preserve plants from frost damage. The foregoing examination of acceptable climate

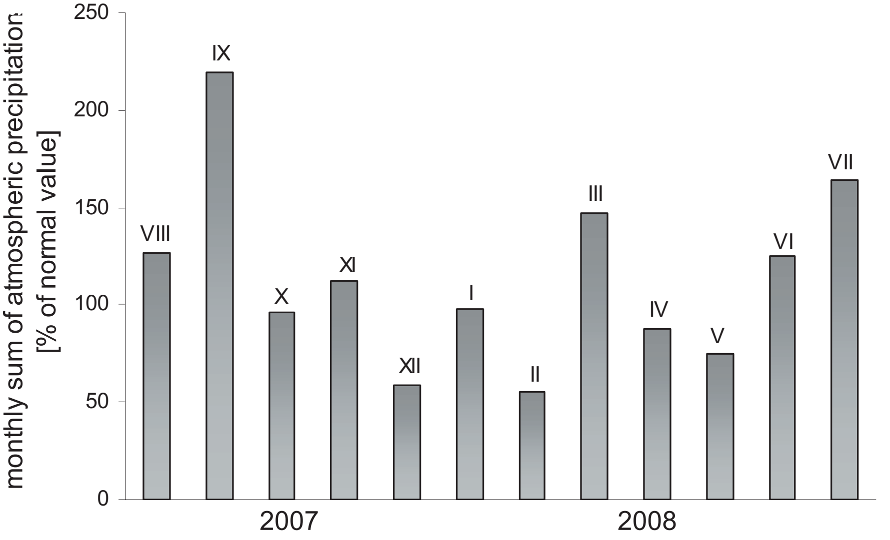

Fig. 6. Monthly sum of atmospheric precipitation for region of West Slovakia in % of normal values (period 1961–1990) in the years 2007–2008.

conditions determined that rapeseed should not be cultivated in lowland and dry regions [for complete detail, please see Masarovičová et al. (2008b)]. The Slovak Hydrometeorological Institute in Bratislava published data concerning the spatial analysis of air temperature and precipitation for Western Slovakia in 2007 (SHMÚ, 2009a) and 2008 (SHMÚ, 2009b), as depicted in Figures 5 and 6. In general, the 2007/2008 growing season can be characterized as favourable for rapeseed plant growth. The rapeseed was sown in August 2007 when both air temperature and precipitation values were above normal, and the deviations from the monthly averages were as follows: air temperature was plus 3.5 °C and precipitation measured 127% of normal values. However, the September and December months registered the following readings ; decreased temperature by -1.5 and -0.4 °C of normal values, plus an increase in precipitation for September of 219%, with October to December values fluctuating between 59 and 112% of normal values. The winter months of January and February 2008 exhibited above-normal temperatures with deviations from monthly averages of plus 4.75 °C in January and 3.5 °C in February. There was also decreased precipitation, registering 98% of normal values in January and 55% in February. The spring months preceeding the July 2008 harvest recorded 1.5 to 2.5 °C above the monthly temperature averages, while precipitation fluctuated between 75 and 164% of normal values (Figs 5 and 6).

Based on this data, it can be concluded that the general weather course in the 2007/2008 growing season was favourable for all the important ontogenetical development stages of rapeseed growth. This was apparent in the sowing, flowering and seed maturation processes. Moreover, Jambor (2007) has also recommended cv. Oponent as a suitable cultivar for the MPR region.

Conclusion

The production potential, oil content and fatty acid composition were studied in some cultivars of *Brassica napus* L. subsp. *napus* in reference to Slovak climate conditions. Six rapeseed cultivars were tested in the rapeseed, maize and potato production regions of Slovakia. Based on meteorological data it can be concluded that the weather course in both the 2007 and 2008 growing seasons was favourable for all the important stages of ontogenetical development within the growth cycle of sowing, flowering and seed maturation. High values of seed production, oil content and oil production, and the important parameter for FAME production of appropriate fatty acid composition, were estimated in the Czech cultivar Oponent. Considering all the studied quantitative and qualitative parameters, it was concluded that this Oponent cultivar, which is detailed in the work of Masarovičová et al. (2010), is ideally suited to Slovak climate conditions.

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