

Suitability of Soil and Climate for Oilseed Rape Production in the Republic of Croatia

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Summary

The paper describes the suitability of soil and weather conditions for oilseed rape production in the agricultural region of the Pannonian Plain in the Republic of Croatia. Soil suitability was estimated on the basis of the existing soil properties. There are 1,169,626 ha of soils suitable for oilseed rape production in the Pannonian agricultural region of the Republic of Croatia, of which 229,839 ha are highly suitable soils (class S-1), 351,392 ha are moderately suitable soils (class S-2), and 588,395 ha are marginally suitable soils (class S-3). On marginally suitable soils oilseed rape should not be grown. To satisfy the planned raw oil requirements of the Republic of Croatia, 60,000-70,000 ha should be allotted to oilseed rape production. Suitability of climate conditions for oilseed rape production was assessed on the basis of the analysis of weather conditions for seven locations in the Pannonian agricultural region over 30 years (1971-2000). Oilseed rape had almost optimal temperature conditions for good emergence and strong initial growth and autumn growth (mean monthly air temperature 15.4°C). In the winter period (November, December, January, February), mean monthly air temperature was 2°C, and mean minimum air temperature was -1.5°C. In the spring period, mean monthly air temperature was 8.4°C. In the last part of the growing period (May, June), mean monthly air temperature was 17.3°C. From 528 mm (Osijek) to 718 mm (Sisak) of precipitation was recorded over the growing period, which fully satisfies water requirements of oilseed rape. The analysis clearly shows that, under the agroecological conditions prevailing in the Republic of Croatia, there are no expressly critical parts of the growing period with regard to lack of precipitation. The most critical period is the sowing-emergence time, since very dry August and September, i.e. lack of moisture for satisfactory and uniform emergence of oilseed rape, were recorded in eastern Croatia in some years.

Key words

oilseed rape, soil properties, weather conditions, Croatia

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Introduction

According to the data of the Central Bureau of Statistics, oilseed rape participates with 1.3% in the sowing structure of the Republic of Croatia. Total areas under oilseed rape in the last 15 years (1993-2007) varied from 5,356 ha (1997) to 20,150 ha (2005). Largest areas under oilseed rape (98.1%) are in the agricultural region of the Pannonian Plain in the Republic of Croatia, i.e. in the territory of 11 counties. Average oilseed rape yields in the Republic of Croatia have shown an increasing trend in the last 15 years, varying between 1.52 and 3.01 t/ha in particular years. These results are not satisfactory, since average seed yields of over 3.0 t/ha are achieved in agriculturally developed countries (e.g. in Germany). Total oilseed rape production in the Republic of Croatia in the last 15 years ranged from 11,181 to 41,275 tons per year. These quantities do not satisfy the demands of our three vegetable oil factories (Zvijezda d.d. – Zagreb, IPK tvornica ulja Čepin, ABN – Zagreb), and the completed (60,000 t) and planned (100,000 t) capacities for biodiesel fuel production.

Major prerequisites for efficient oilseed rape production are suitable soils and favourable weather conditions. Oilseed rape grows best on deep, humus and calcium rich loam-clay soils, which are not prone to mud bogging and crust formation. Undeveloped soils, of poor water-air properties, with marked depressions in which water stagnates, are not suitable for oilseed rape production because of plant density reduction and thereby yield decrease (Mustapić and Gašperov, 1985). Owing to precipitation deficiency, critical periods occur at the time of oilseed rape emergence and from the flowering stage to the seed filling stage. Lack of precipitation at the flowering stage until the seed filling stage does not only affect seed yield and seed components (Champolivier and Merrien, 1996) but also oil yield (Istanbuloglu et al., 2010) and its quality (Pospišil et al., 2007). As regards temperature, two critical periods occur during the oilseed rape growing period. The first critical period may occur in winter when oilseed rape can perish due to long-lasting frosts and low temperatures (Mustapić et al., 1986). The second critical period occurs in spring, from the initial flowering stage until ripening, when maximum air temperatures over 30°C reduce seed yields (Kutcher et al., 2010). Yield reduction is due to the formation of fewer flowers and seedpods, lower seed mass and a smaller number of seeds per pod (Morrison and Stewart, 2002). The objective of this study was to evaluate the suitability of soil and weather conditions for oilseed rape production in the agricultural region of the Pannonian Plain in the Republic of Croatia.

Material and methods

Soil suitability for oilseed rape production was assessed according to the FAO soil classification criteria (FAO, 1976; VIDAČEK, 1981), in which soils are classified into five suitability classes. The first three classes include soils suitable for oilseed rape production, the first of which includes highly suitable, second moderately suitable, and the third marginally suitable soils. The remaining two classes are soils not suitable for oilseed rape production.

The source of pedological data was the digital soil map, scale 1:500000, and the ground elevation map, scale 1:300000, from the archives of the University of Zagreb, Faculty of Agriculture, Department of Soil Science (Bogunović et al., 1997; Husnjak et al., 2000; Husnjak et al., 2005).

Suitability of climatic conditions for oilseed rape production was assessed on the base of the analysis of weather conditions (mean monthly air temperature, monthly minimum and maximum air temperatures, monthly precipitation) for seven weather stations (Osijek, Slavonski Brod, Đurđevac, Križevci, Varaždin, Zagreb-Maksimir and Sisak) in the agricultural region of the Pannonian Plain over 30 years (1971-2000). Data from the Meteorological and Hydrological Service of Croatia was used for the analysis of weather conditions (Zaninović et al., 2008). Oilseed rape growing period was divided into four periods: 1st period – autumn growth (August to October), 2nd period – winter repose (November to February of the following year), 3rd period – spring growth until flowering (March to April), and 4th period – end of flowering to ripening (May and June).

Results and discussion

There are 1,169,626 ha of soils suitable for oilseed rape production in the Pannonian agricultural region of the Republic of Croatia, of which 229,839 ha are highly suitable soils (class S-1), 351,392 ha are moderately suitable soils (class S-2), and 588,395 ha are marginally suitable soils (class S-3), (Figure 1).

The first suitability class (S-1) includes soils of very deep and deep ecological depth, with permeable, loamy to silty clay loam texture, good natural draining, aerated, neutral to very low acid reaction, on level terrains.

The second suitability class (S-2) includes deep luvic soils on loess, of low humosity, well drained, with predominantly loamy texture, moderate permeability and compaction, low to very acid reaction, on mildly sloping terrains. A smaller part of this class also comprises soils hydroameliorated through canals from humogley loamy, and drained pseudogley soils.

The third suitability class (S-3) of soils for oilseed rape production comprises soils characterized by limitations such as: stagnation of precipitation water, sandy texture, high acidity, medium deep groundwater table, unfavourable water-air relationship, and incomplete to poor drainage. Due to these limitations, oilseed rape should not be grown on these soils.

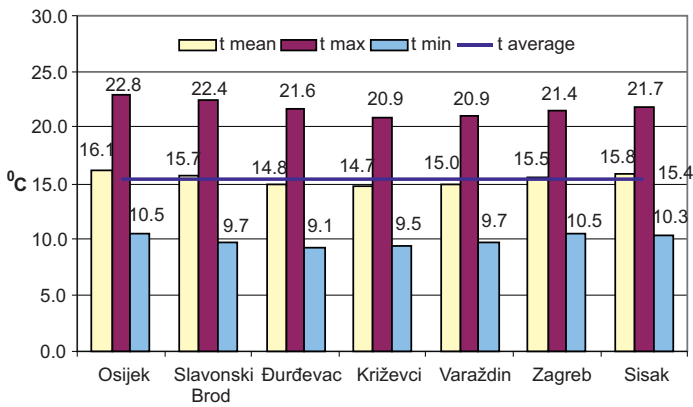
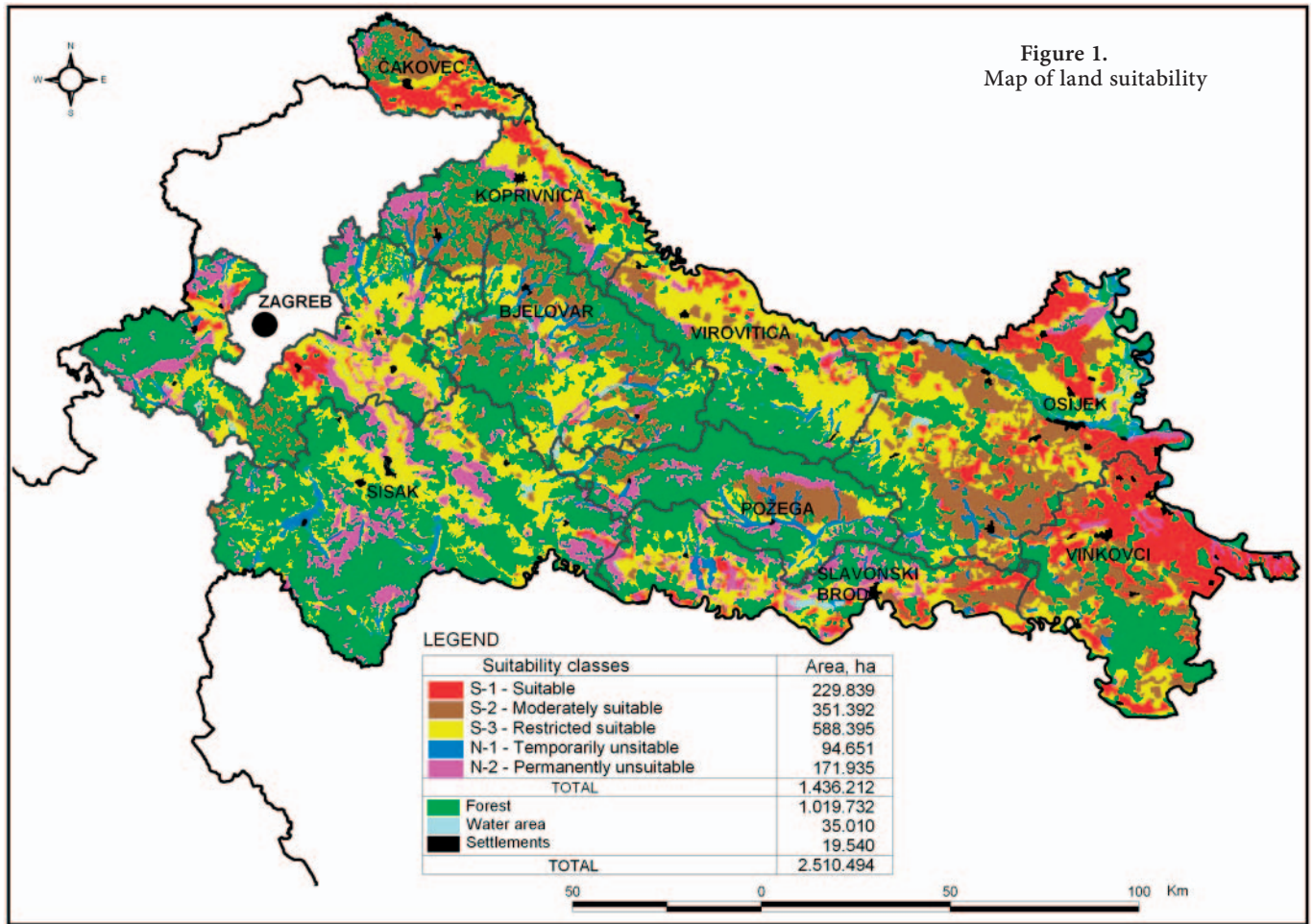
Oilseed rape has almost optimal temperature conditions for good emergence and strong initial growth as well as for its autumn growth (August - October). The average mean monthly air temperature in the autumn growth period is 15.4°C (Graph 1).

The average amount of precipitation during oilseed rape autumn growth is 224 mm (Graph 2). Eastern Croatia (Osijek) has the lowest precipitation, which in some years causes slower and non-uniform emergence of oilseed rape.

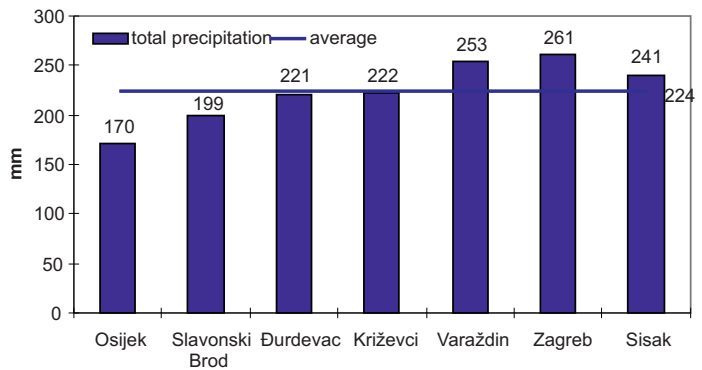
In the winter period (November, December, January, February), the average mean monthly air temperature is 2°C while the average minimum air temperature is -1.5°C (Graph 3). The greatest hazards in this period are low minimum air temperatures, especially if soil is saturated with water and without a snow cover (Mustapić et al., 1986).

The average amount of precipitation in winter is 222 mm (Graph 4). The lowest amount of precipitation falls in Osijek (187 mm) and the highest in Sisak (257 mm).

In the spring period (March, April), the average mean monthly air temperature was 8.4°C (Graph 5).



Graph 1. Mean, minimum and maximum monthly air temperatures during the period of oilseed rape autumn growth (August - October)

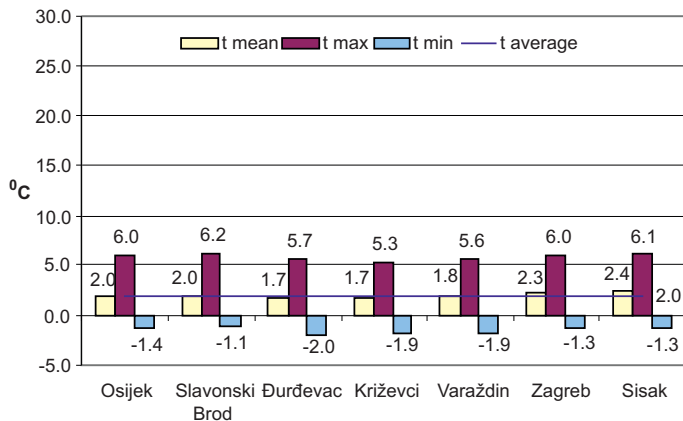


Graph 2. Total monthly precipitation during the period of oilseed rape autumn growth (August - October)

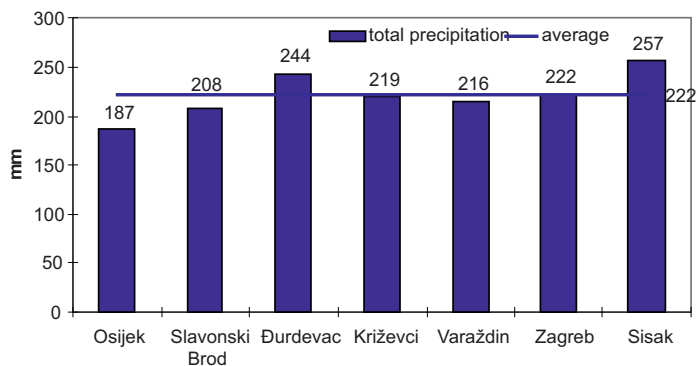
The average amount of precipitation in the period of oilseed rape spring growth was 108 mm (Graph 6). The highest amount of precipitation falls in Sisak (124 mm) and the lowest in Osijek (92 mm). As this is the period in which oilseed rape needs most water, especially at the stage of its intensive growth, the above

amounts seem insufficient. However, if there is sufficient winter moisture, these amounts are satisfactory for good spring growth and nutrient uptake.

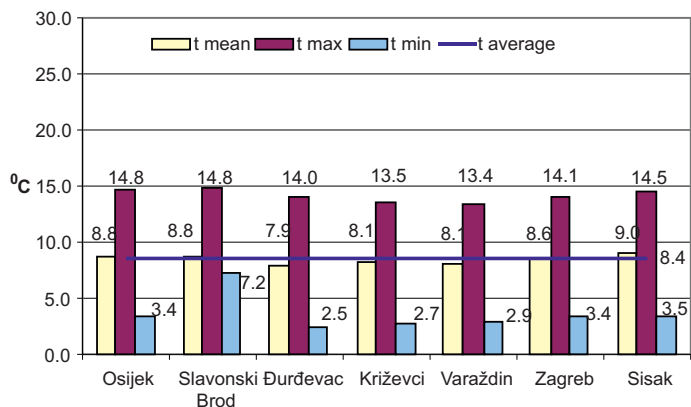
From the end of oilseed rape flowering to ripening (May, June), the average mean monthly air temperature was 17.3°C (Graph 7).



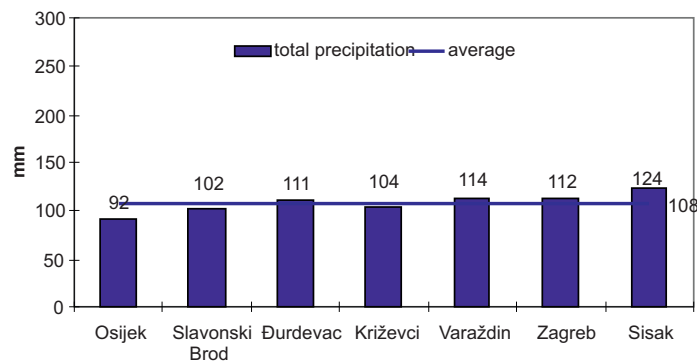
Graph 3. Mean, minimum and maximum monthly air temperatures in the winter period (November, December, January, February)



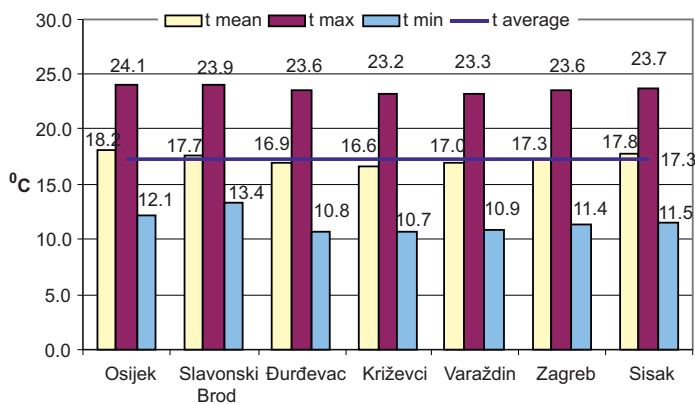
Graph 4. Total monthly precipitation in the winter period (November, December, January, February)



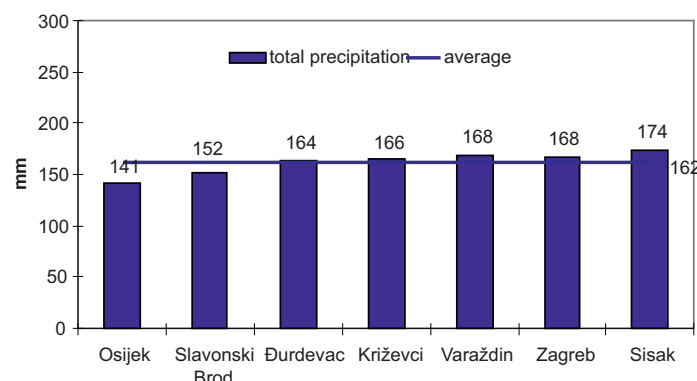
Graph 5. Mean, minimum and maximum monthly air temperatures during the period from oilseed rape spring growth to flowering (March - April)



Graph 6. Total monthly precipitation during the period from oilseed rape spring growth to flowering (March - April)



Graph 7. Mean, minimum and maximum monthly air temperatures in the period from the end of oilseed rape flowering to ripening (May - June)



Graph 8. Total monthly precipitation during the period from the end of oilseed rape flowering to ripening (May - June)

Average maximum air temperatures above 30°C are critical at the flowering stage (Kutcher et al., 2010). In the Pannonian Plain of the Republic of Croatia, average mean monthly air temperatures varied from 23.2°C (Križevci) to 24.1°C (Osijek).

Average precipitation of 162 mm was recorded in the last part of the growing period (Graph 8). This is also a critical period for oilseed rape because of the drought, which has a strong impact on seed yield and quality. On the other hand, frequent and ex-

cessive precipitation depresses seed filling and silique formation, and favours disease development.

The sum of mean daily air temperatures in the oilseed rape growing period ranged from 2452°C (Križevci) to 2737°C (Sisak).

Between 528 mm (Osijek) and 718 mm (Sisak) of precipitation falls over the growing period, which fully satisfies water requirements of oilseed rape.

Conclusions

In the agricultural region of the Pannonian Plain in the Republic of Croatia, oilseed rape can be grown without greater limitations at an area of 581,231 ha.

To satisfy the planned raw oil requirements of the Republic of Croatia, 60,000-70,000 ha per year should be allotted to oilseed rape production (10-12% areas under soils from suitable to moderately suitable classes).

In the agroecological conditions of the Republic of Croatia, air temperatures are not a limiting factor for oilseed rape production. There are no expressly critical periods in terms of precipitation deficiency in the growing period either. The most critical period is the sowing-emergence time, since very dry August and September, i.e. lack of moisture for satisfactory and uniform emergence of oilseed rape, were recorded in eastern Croatia in some years.

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