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AGROMETEOROLOGICAL AND TECHNOLOGICAL CONDITIONS FOR RAPE CULTIVATION IN DOBRUDJA

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Key words: Rape, Dobrudja, agrometeorological, drought, sowing period.

Abstract. The rape culture has a number of disadvantages: the preparation of the germination bed is difficult if there is drought during the sowing period, and additional water supply, provided by irrigation, is necessary; rape is sensitive to frost and to great temperature alternations in winter, as well as in spring; it is sensitive to frost during the budding-flowering period.
Over the recent years, the rape culture has been compromised due to climatic accidents. It is difficult to establish the optimum sowing time in autumn so that when winter comes the rape plants should display a rosette of leaves, should have a collet diameter of 1 cm ± 2 mm, should have a well developed root system, the pivot should penetrate the earth down to 10-15 cm, and the plants should be hardy (they should have sugars accumulation and not be very turgescent). These are the conditions needed for rape to resist during the harsh conditions of winter in this region. The alternation between frost and thaw, as well as frosts during the budding and flowering periods can affect the rape culture. At maturity, another danger may arise as the interval between full maturity and harvesting is short, the siliquae are slightly dehiscent and rain, at this stage, followed by summer temperatures of over 30ºC associated with wind, leads to the total shedding of the seeds and the crop may thus be completely compromised in a very short time.

Introduction

Rape is an oleaginous plant known before Christ in India, China and Korea. In Europe, it is mentioned in the Netherlands in 1700, from where it passes on to Germany, Poland, Denmark, Switzerland and Russia. The high content of oil in rape seeds (42-49%) places rape third at global level in regard to oil production. Rape provides 12% of the oleaginous raw materials processed yearly and 15% of the global oil production. Rape oil is used in human food, in the production of margarine, but also in the production of varnish, paint and soap. A new use, through the esterification of rape oil, is the production of biofuel, which is also

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employed in agriculture on internal combustion engines. The straws are used to make oriented strand board (OSB). In early spring or late autumn, rape can be used as green feed due to the accelerated growth rate. Among the agricultural advantages of the culture, we mention: early sowing and harvesting outside the busy time periods; favorable reaction to fertilization; the use of machine systems similar to the other straw cereals; excellent previous plant for autumn straw cereals but also for successive crops because it clears the land early and leaves the soil clean of weeds; it increases soil fertility and prevents erosion on inclines; it improves the physical properties and fights weeds well; it exploits well the soil humidity accumulated during winter; the production costs are lower than those of other crops; the yield is comparable to that of sunflower; the selling of the production is not problematic because rape is sought after by the oil factories being well exploited even as an export product (in the EU, it is expected that biofuels should represent 5% of the total fuels used); it is an excellent early melliferous plant (it provides approximately 50 kg of honey/ha).

1. Material and research method

The progress of the recent years in improving rape and in the multiple uses of oil has led to the cultivation of this plant on more land, rivaling with sunflower. The yield obtained in rape is several times higher than in sunflower.

Tab. 1. The situation of rape crops in Europe in 2006

Crt. No.	Country	Surface (ha)	Total production (mill t)
1.	Austria	42582.00	3224.44
2.	Belgium	9606.00	3536.96
3.	Bulgaria	15837.00	1797.25
4.	Czech Republic	292247.00	3011.74
5.	Denmark	125400.00	3466.51
6.	Estonia	62492.00	1353.92
7.	Finland	106900.00	1386.34
8.	France	1405603.00	2948.55
9.	Germany	1429000.00	3734.43
10.	Greece	2000.00	2000.00
11.	Hungary	142649.00	2340.80
12.	Ireland	5000.00	3400.00
13.	Italy	3535.00	1686.28
14.	Lithuania	150800.00	1449.52
15.	Luxemburg	4782.00	3398.16
16.	The Netherlands	3000.00	4333.33
17.	Poland	623853.00	2647.30
18.	Romania	122511.00	1707.27
19.	Slovakia	122511.00	2119.40
20.	Slovenia	2809.00	1776.79

21.	Spain	5700.00	1578.95
22.	Sweden	90760.00	2434.99
23.	England	575000.00	3252.17

** FAOSTAT- faostat. fao.org*

Tab. 2. The evolution of rape crops in the European Union between 2008-2010

Years	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Cultivated surface (ha)	4 867 014	5 400 211	6 533 842	6 128 538	6 480 548	6 912 194
Average crop yield kg/ha	3215.4	2983.8	2819.3	3088.5	3302.0	2949.0

**Data taken from the FAO statistics*

Tab. 3. The situation of rape and sunflower crops at global and European level between 2008-2010

Year	**Specification**	**Rape**		**Sunflower**	
		Surface (ha)	**Average crop yield (kg/ha)**	**Surface (ha)**	**Average crop yield (kg/ha)**
2008	Global	30 617 845	1887.0	25 284 886	1432.6
	Europe	8 534 291	2736.2	14 535 217	1510.3
2009	Global	31 615 834	1961.7	24 187 403	1347.9
	Europe	8 522 888	29122	14 109 873	1458.1
2010	Global	31 680 945	1864.6	23 104 402	1322.6
	Europe	8 787 770	26261	14 262 620	1394.7

** Data taken from the FAO statistics - faostat.fao.org*

Tab. 4. The surface cultivated with rape and the yield obtained in Constanta County between 2000-2007

Years	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Cultivated surface (thousand ha)	12688	17652	9775	1946	6792	20438		102974
Average crop yield (kg/ha)	1406	741	410	236	2006	1507		2484

**The National Institute of Statistics, Constanta County Statistics Office - Statistical Yearbook of Constanta County 2008*

Tab.5. The surface cultivated with rape and the yield obtained in Constanta County between 2008-2010

Years	**2008**	**2009**	**2010**
Cultivated surface (ha)	138527	63318	150318
Average crop yield (kg/ha)	2163	1231	1875

** The National Institute of Statistics, Constanta County Statistics Office - Statistical Yearbook of Constanta County*

Eastern European countries that are in a process of integration in the European Community have land with high agricultural potential. Under conditions of average crop yields comparable to those of the EU, this potential could be used to produce crops with a true energetic potential.

Tab. 6. Cultivated surface and the yield obtained in rape in Constanta County

Crt. No.	Year	Cultivated surface - ha-	Average yield -kg/ha-
1.	2000	12688	1406
2.	2001	17652	741
3.	2002	9775	410
4.	2003	1946	236
5.	2004	6792	2003
6.	2005	20438	1507
7.	2006	8281	1474

** Statistical Yearbook of Constanta County, 2007*

Tab. 7. Cultivated surface and the yield obtained in rape in Constanta County

Crt. No.	Year	Cultivated surface - thousand ha-	Average yield -kg/ha-
1.	1990	13.1	831
2.	1991	8.8	994
3.	1992	1.7	791
4.	1993	1.5	929
5.	1994	0.3	942
6.	1995	0.3	1178
7.	1996	1.7	1086
8.	1997	7.2	1620
9.	1998	25.3	1050
10.	1999	83.6	1294
11.	2000	68.4	1113
12.	2001	82.4	1235
13.	2002	74.6	481
14.	2003	17.1	473
15.	204	49.7	1984
16.	2005	87.8	1681
17.	2006	110.1	1590,0
18.	2007	348.8	998,0

**Website, Ministry of Agriculture and Statistical Yearbook of Romania, 2007*

The exploitation of the agricultural potential by encouraging alternative crops of industrial plants, such as rape, with the purpose of providing an alternative energy source as fuels for tractors and agricultural self-propelled machines, represents a current energetic desire with large perspectives of development in the rape crop in Romania.

2. Results obtained

With the integration in the European Union and the reduction of import of energy products, Romania must develop a new category of fuels that regenerate year after year, unlike fuels from hydrocarbons, which do not regenerate once they are taken out of the Earth crust from deep underground.

In Romania, rape was cultivated on large surfaces before the First World War and between the two World Wars. Thus, in 1913, rape occupied 80.38 thousand ha, while in 1930 it occupied approx. 77.32 thousand ha. After 1948, the surfaces varied from one year to the next, slightly exceeding 20 thousand ha only in 1953, 1955 and 1956. In 1935, the statistical yearbook of Romania mentions 5.9 thousand ha. The oil content of colza rape seeds exceeds 40% in the cultivars free of erucic acid (type“0”). In cultivars free of erucic acid and glucosinolates (tip“00”), the oil content was between 43.3 and 48.3%. In cultivars grown in our country, the seed oil content is 44.5-45.8%. In general, colza seed oil content is between 43-48%.

2.1. Biological particularities. Colza rape is an annual plant with well developed tap root, with few lateral ramifications. It penetrates the earth down to a depth of 70-100 cm. Under favorable conditions, the root can sometimes reach greater depths, down to 300 cm. The deep root penetration is influenced by numerous factors such as: texture, fertility and humidity of the soil, as well as the cultivation technique. The lateral roots are spread over a diameter of 20-40 cm. Most of the root mass is spread at a depth of 25-45 cm. The stem is erect, 1.3-1.5 m tall (sometimes even 2 m) and well ramified. The number of branches ranges between 5 and 10; the degree of ramification also depends on the crop density. The vegetation period is 270-300 days for the autumn cultivars and 110-130 days for the spring cultivars.

Requirements in terms of climate and soil. High and profitable rape productions can be obtained especially when the growers favor the positive interaction between the environmental conditions and the technology applied.

Rape can be cultivated with good results in the zone of maize and autumn cereals, but it must not occupy surfaces to the expense of sunflower in its main cultivation zone (Bîlteanu 2001). In these zones, the sums of autumn degrees accumulated during the vegetation period of 270-300 days is 2100-2500°C in autumn rape and 1500-1800°C (in 110-130 days) in the spring cultivars (Borcean

2006, Tabără 2005). The most favorable zones are those wet and cool, with average temperatures between 7-10°C (Canţăr 1965, Ştefan 2003).

From the point of view of cold resistance, rape is much like autumn barley (Său1escu, 1947 quoted by Bîlteanu 2001), being more sensitive than autumn wheat. Still, extremes of -20°C and even -25°C are cited in the specialized literature, when rape was not destroyed by cold (Canţăr 1965, Tabără 2005).

Fig. 1. Requirements in terms of temperature and water on vegetation stages

Phenophase	Requirements in terms of temperature	Requirements in terms of water (mm)
Vegetation period: 270-300 days	2100 - 2 500 (Canţăr 1965, Fazecaş 1983)	450 – 650 (100-150 mm in July-August) 450 – 630 (100-150 mm in July-September) 450 – 650 (100-150 mm in August – September)
Sowing springing	130°C (Falisse 1992) 130-170°C (Σt > 0°C) (Ştefan 2003)	
Sowing – winter beginning	800-900°C (Σt > 0°C) or 400-450°C (Σt > 6°C) (Bîlteanu 2001, Ştefan 2003)	40-50 mm for the formation of the rosette
	Hardening	
Wintertime	-7-10°C (moist soil, sudden cold)	50 mm
	- 18 -20 °C, even without snow	
	-20-25°C with snow layer of maximum 20 cm	
Vegetation resuming in the spring	From 5°C	
Stem elongation – flowering	12 -15°C (Ştefan 2003)	50-75
Flowering	15-20°C (Ştefan 2003) 360-380 °C (Falisse 1992)	80-100
End of flowering - maturity	15-20°C (Ştefan 2003) 370-900°C (Falisse 1992)	150-200 (Dumbravă, 2004) 170-290 (Ştefan 2003)

**Bibliography: Falisse 1992, Bîlteanu 2001, Ştefan 2003, Dumbravă 2004, Canţăr 1965, Fazecaş 1983*

Under favorable conditions, rape can resist up to 18-20°C below zero, even when the crop is not covered by snow (Canţăr 1965). According to various authors, favorable conditions for cold resistance mean that: the plants underwent a period of hardening of at least 40 days (Tabără 2005); the hardening is accomplished in 3 stages. At temperatures between 5 and 2°C, plants stop growing and accumulate

metabolites (ATP, NADPH, simple sugars, amino acids, soluble proteins); at temperatures around 0°C, phospholipids disintegrate; at temperatures below 0°C, cells dehydrate due to the modification of the osmotic pressure, which took place as a result of the phospholipid degradation.

Vernalization occurs during this hardening period (Bîlteanu 2001), with optimum temperatures between 0-7°C (Falisse 1992); the plants are in phenophase, with a rosette of 6-8 formed leaves, with a collet diameter of 6-8 mm and the pivot length (root) of 15-18 cm; the soil is dry. Between sowing and the beginning of winter, plants must accumulate 800-900°C ($\Sigma t > 0$°C) or 400-450°C ($\Sigma t > 6$°C) (Zahan 1983, Pop, 1985 quoted by Bîlteanu 2001, Ştefan 2003). If the cold is preceded by warm weather or if the soil is too moist, temperatures of $-7 \div -10$°C can destroy the plants (Canţăr 1965, Bîlteanu 2001).

The snow layer represents a good protection against the cold. However, if the layer of snow is too thick (over 20 cm), the soil is wet and not frozen and the plants strongly developed, rape may die (Canţăr 1965, Fazecaş 1983).

Even though the biological threshold of rape is 6-8°C (Bonciarelli quoted by Bîlteanu 2001), stem elongation in spring begins when temperature is over 5°C. According to Falisse (1992), plants resist up to –1°C during flowering, and up to –5°C when the siliquae form. The spring cultivars resist at temperatures of –2, –3°C (Tabără 2005) or even –8°C (Falisse 1992). Tabără (2005) remarks that all the rape cultivars are sensitive to temperature oscillations (fig.1). In spring, as it grows, rape becomes more and more sensitive to low temperatures. The frosts that occur during the flowering period determine the destruction of the entire crop (Bîlteanu 2001, Ştefan 2003). Most specialists consider rape a demanding plant in terms of moisture. The favorable areas are believed to be those where 450 - 650 mm of precipitations fall yearly. Even though the multi-annual mean of precipitation in Dobrudja is 350-400 mm (Sin 2000), Constanta County, the least favorable area in this regard, has the largest surfaces cultivated with rape (Table 4-6), sometimes with very good results (2004).

Rape is considered demanding in terms of moisture because the lack of water during the critical periods may compromise the crop. The transpiration coefficient is high (600-740). Favorable are those areas where 450-650 mm of precipitations fall yearly, of which 100-150 mm between August and September.

The following periods are critical in terms of water: springing – rosette formation and flowering-fructification. The beginning of active vegetation, early in spring-summer and the rapid growth rhythm make rape exploit efficiently the water accumulated in the soil during the winter (Borcean, 2001).

Rape goes through drought with difficulty. The large water reserves from the soil play an important role in the plant development, especially in the phases

between flowering and fruit formation. By developing intensely in early spring, rape fully uses the moisture accumulated during the winter, which is why it offers satisfying results even in the dry regions. Still, the highest productions are obtained in regions rich in atmospheric precipitations. We must specify that greater atmospheric humidity influences favorably the plant development.

Rape offers good results in areas where 450-650 mm of precipitations fall yearly, with a maximum in July and August (Canţăr 1965). In general lines, we must keep in mind that rape does not find favorable vegetation conditions every year (Bîlteanu 2001).

Requirements in terms of soil. It is a demanding plant; it prefers deep and permeable soils with medium texture, rich in humus and calcium, with neutral reaction. It offers good results on alluvial soils, chernozems and brown-red forest soils.

By taking into account the climatic requirements mentioned above, the favorable areas for rape cultivation should be the ones described below (reproduced in several articles).

2.2. The sowing period. The conclusion that can be drawn from the research realized in our country is that for autumn vegetation colza rape needs 800-900 degrees of active temperatures above zero. If this amount of heat accumulates and if the moisture conditions are appropriate, the plant forms a strong root and a rosette of 6-8 well-developed leaves, a biological state which offers the plant resistance to unfavorable factors during winter, especially at low temperatures. The conditions mentioned are accomplished by sowing the colza rape between September 5 and 15, in the southern part of the country and between September 1 and 10 in the other areas. As a general rule, in areas outside the Wallachian Plain and Banatului Plain, the sowing of colza rape can begin after August 20. In the Wallachian Plain and Banatului Plain, sowing begins after September 1.

Conclusions

- The sums of temperature degrees accumulated during the vegetation period of 270-300 days is 2100-2500°C in autumn rape and 1500-1800°C (in 110-130 days) in spring cultivars (Borcean 2006, Tabără 2005). The most favorable zones are those wet and cool, with average temperatures between 7-10°C (Canţăr 1965, Ştefan 2003).
- In terms of cold resistance, rape is much like autumn barley (Său1escu, 1947 quoted by Bîlteanu 2001), being more sensitive than autumn wheat. Still, in the specialized literature, the limits quoted are -20°C and even -25°C, when rape was not destroyed by cold (Canţăr 1965, Tabără 2005).

- Under favorable conditions, rape can resist up to 18-20°C below zero even when the crop is not covered by snow (Canţăr 1965). According to various authors, the favorable conditions for cold resistance mean that the plants underwent a period of hardening of at least 40 days (Tabără 2005); the hardening is accomplished in 3 stages.
- Rape is considered demanding in terms of moisture because the lack of water during the critical periods may compromise the crop. The transpiration coefficient is high (600-740).
- Favorable are those areas where 450-650 mm of precipitations fall yearly, of which 100-150 mm between August and September.
- The following periods are critical in terms of water: springing – rosette formation and flowering-fructification.
- The beginning of active vegetation, early in spring-summer and the rapid growth rhythm make rape exploit efficiently the water accumulated in the soil during the winter (Borcean, 2001).
- Rape goes through drought with difficulty. The large water reserves from the soil play an important role in the plant development, especially in the phases between flowering and fruit formation.
- Irrigation is necessary in the south of the country. A watering is applied in autumn with 300-400 m^3 water/ha in order to stimulate plant springing and the formation of the basal rosette before winter. In spring, watering is needed at the beginning of the formation of the first siliquae, with 400 – 500 m^3/ha and at the end of flowering, with 500-600 m^3/ha. Late watering favors the falling of the plants and the attack of aphids.

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