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CAMELINA CULTIVATION FOR BIOFUELS PRODUCTION

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Abstract

Recently studies have been carried out regarding Camelina sativa benefits. This oilseed plant that belongs to Brassicaceae family presents a major interest due to the fact that it can be a renewable resource for sustainable biofuels production. The oil obtained by crushing the seeds is rich in polyunsaturated fatty acids and can be processed in order to obtain biokerosene for aviation. Camelina oil has the property to resist at minus 47-48°C, the requirement for aviation fuel, due to negative temperature in the area the aircraft fly. In our study, Camelina sativa was cultivated in several locations from Romania: in the North (Iasi and Satu-Mare county), in the West (Arad county) and in the South (Calarasi county). Two camelina varieties were tested: GP 202 and GP 204. The aim of this study is to assess the camelina yield potential and identify the optimum cultivation technology. The climatic conditions and the soils were monitored during the tested period. The production was influenced by the sowing date. The best results were obtained at Iasi (2.9 t/ha), Calarasi (1.2 t/ha) and Satu-Mare (1.2 t/ha).

Keywords: *aviation, biofuel, Camelina yield, Camelina sativa, cultivation technology.*

INTRODUCTION

The issue of plant-based biofuel sustainability is very complex. The whole chain involved in biofuel production depends on multitude of factors, such as: GHG (greenhouse gases) emissions reduction, land use change, indirect land use change, land availability (food vs. fuel dilemma), agricultural practices, water consumption reduction, limiting negative effects on biodiversity, biofuels efficient use in the economic and energy sectors, logistics and social impact (Lee et.al, 2008; Moser, 2010; Shonnard et al., 2010; Amigun et al., 2011). According to EPA (Environmental Protection Agency). *Camelina sativa* can be successfully used for advanced biofuel production, meeting all the above mentioned criteria.

Camelina sativa is an annual plant belonging to *Brassicaceae* family. It adapts to cold climate and can be cultivated in northern regions (Gugel and Falk, 2006; Moser, 2010). Its recent research has focused on introducing it in rotational crops with cereals (Moser, 2010), as well as in double cropping (Schillinger et al., 2012; Gesch and Archer, 2013). Its vegetation period is short (85-100 days) and, unlike rapeseed, it is more resistant to drought, pests and diseases (Putnam *et al*. 1993; Gugel and Falk, 2006; Martinelli and Galasso, 2010; Moser, 2010) It requires minimal or no tillage and no special equipment (Dobre *et al,* 2011).

The oil obtained from *Camelina sativa* seeds is rich in polyunsaturated fatty acids (Abramovic and Abram, 2005) and can be used for various purposes: biodiesel (Fröhlich and Rice, 2005; Kruczyński, 2013), biojet fuel (Moser, 2010; Shonnard *et al*., 2010, Jurcoane *et al*. 2011), heating oil, naphtha, liquefied petroleum gas (EPA, 2013), paint, varnish and cosmetics industry (Zubr,1997). Moreover, the by-product that remains after camelina seed crushing can be used in animal feeding in small amounts (Putnam *et al*. 1993, Jurcoane *et al*. 2011).

Our study is aimed at identifying the best camelina cultivation technology using low-inputs and testing the potential of *Camelina sativa* varieties in several locations from Romania.

MATERIALS AND METHODS

Camelina sativa cultivation and harvesting

In Romania, during 2011-2012, *Camelina sativa* was cultivated in the North (Iasi and Satu-Mare county), in the South (Calarasi

county) and in the West (Arad county) in non-irrigated conditions. Two *Camelina sativa* varieties were tested: *GP 202* and *GP 204,* German varieties. The camelina crop was sown in different periods at the depth of 1-2cm. The climatic conditions and the soil were monitored during testing period. Soil samples were taking during camelina vegetation at the depth of 20cm.

In Iasi county (Tiganasi village location), 2 ha were sown with *Camelina sativa GP 202* and 1 ha with *GP 204* variety, using an Amazone sowing machine. The distance between rows was 25 cm, according with Imbrea *et al.* recommendations, 2011. The previous crop was represented by mustard. Before sowing, the following soil works were carried out: stubble ploughing after previous crop harvesting, rolling and leveling. Inputs applied for camelina crop were the highest from all locations. On the middle of August 2012, 200 kg/ha N: P: K 15:15:15 and 200 kg/ha N: P: K-5:15:30 were applied. During flowering period and when the plants had almost all the capsules formed, 3 kg/ha of foliage fertilizer were applied. The seeding rate was 5 kg/ha for GP 202 and 5.5 kg/ha for GP 204. Only in this location phytosanitary treatments were applied (1 l/ha *Folicur solo* and 0.1 l/ha *Calypso*) and also a desiccant (3l/ha *Reglone*) was used a week before harvesting time. The harvest took place on 27 June 2012 using a Class Lexion combine, seeding conditioning being done in the same time with harvesting, using a Selector EF 3802 equipment that had very low diameter sieves.

In Satu-Mare County, the trial was located in Acas village. 2 ha were sown with camelina using a SUP 21 seeding machine. Only *Camelina sativa GP 202* was tested. The previous crop was maize. The soil tillage works made were: ploughing, disc harrowing, milling and rolling (before and after sowing). The seeding rate was 10 kg/ha and 200 kg/ha NPK 15-15-15 were applied in autumn. The harvesting was done on 10 July 2012 using a Claas Lexion combine.

In Calarasi County the trial was located near Fundulea city (about1 km). 1 ha for each variety was tested. The seeding rate was 6 kg/ha for both varieties. The previous crop was represented by maize. The distance between rows was 25 cm. The following soil works were carried out: ploughing, disc harrowing, combinatory and rolling (before and after sowing). In March 2012, 150 kg/ha ammonium nitrate was applied. Harvesting was done on 27 June 2012 with a Fendt combine.

In Arad County, the tests were carried out in Buteni village. In this location, 2 ha were sown with *Camelina sativa GP 202* using a SUP 21 seeding machine. The seeding rate was 10 kg/ha. The distance between rows was 12.5 cm. Soil tillage was represented by ploughing, disc harrowing and rolling (before and after sowing). The harvesting took place on 11 July 2012 using a Claas Lexion combine.

Camelina seeds conditioning

After the harvest, the seeds were stored by farmers and were dried naturally (not by using special equipment). They were aired by farmers until they reached a humidity level of 8-9%. The entire yield obtained from all the demo trials was sent to Iasi for conditioning because this location was best equipped i.e. a suitable sieve with round holes of 1,5 mm. The separation process was made for each variety and impurities were removed. A second conditioning was necessary to be performed. The quantity left this process was also stored in Iasi.

Analysis methods

After harvesting and conditioning, IBNA-Balotesti (National Research Development Institute for Animal Biology and Nutrition) analysed the seed oil content. Regarding the soil samples the following analyses were conducted: soil pH using a pH meter, the total carbon and nitrogen content using LECO methodology and the available soil phosphorus content after Olsen's method.

RESULTS AND DISCUSSIONS

In 2011-2012, the climatic conditions recorded in Romania were not favourable for agriculture. In November in the tested locations a low amount of precipitation was recorded (< 2mm). For this reason, the camelina crop planted in autumn did not emerge in December. For the most areas from Romania, in May was recorded a prolonged period with high amount of precipitation followed by a period of drought and high temperatures in June. For instance, In Iasi county from 15 May 2012 to 25 May 2012

daily rainfall was recorded, the amount of precipitations reaching 78.4 mm (from the amount recorded during the whole month).
The land from Iasi and Calarasi locations and Fundulea are preferred for agricultural activities.
Regarding the soils from Satu Mare, Iasi and Calarasi (see Table 1), these had a slightly acid pH, and the soils from Arad a neutral pH. The C/N ratio showed that soil fertility had normal values in Calarasi (C/N: between 10 and 15) and higher values for Iasi trial. The phosphorus concentration determined by Olsen method varied in the tested soils. None of these samples had a very low P concentration (< 4 ppm). The samples taken from Sate Mare, Arad, Calarasi had a low P concentration, which proves that for future tests P fertilization is mandatory.

Table 1. Soil tests results from different locations from Romania during camelina flowering period

Location (county)	pH	Total Nitrogen (%)	Total Carbon (%)	C/N	P (ppm)
Iasi	6.25	0.14	2.52	18	20.31
Calarasi	6.62	0.15	1.84	12.27	11.83
Satu-Mare	6.67	0.14	1.03	7.36	15.84
Arad	7.15	0.14	1.35	9.64	15.13

The camelina crop cultivated in autumn had a good resistance over the winter period and started to emerge in April (Table 2). In April 2012 the plants had 4-6 leaves. During April and May the plants grew rapidly. At the end of the May in Satu Mare, Iasi and Calarasi locations, and all the plants had their capsules formed (Figure 1). The weed infestation was low and no effects on camelina production. In Calarasi county the presence of few plants infested with *Peronospora camelinae* was noticed but no phytosanitary treatments were required. When the distance between rows was 25 cm, the plants were more robust and had numerous branches. Only in Iasi an insecticide and a fungicide with systemic action were applied to prevent *Meligethes aeneus* and *Peronospora camelinae* from damaging the plant.

Table 2. Sowing, emergence and harvesting period.

Location (county)	**Sowing date**	**Emergence date**	**Harvesting date**
Iasi	21 November 2011	05 April 2012	27 June 2012
Calarasi	9 November 2011	20 March 2012	27 June 2012
Satu-Mare	10 November 2011	27 March 2012	10 July 2012
Arad	4 March 2012	11 April 2012	11 July 2012

For the spring trial carried out in Arad county, the flowering occurred in the middle of May and continued at the beginning of June (see Figure 2). No fertilizers no phytosanitary treatments and no desiccant were used.
Harvest reaping started in mid June and finished in July. The harvesting period was the same for both *Camelina sativaGP 202* and *GP 204* varieties.
In Arad County the yield obtained was 0.76 t/ha but the seed oil percentage was higher (32.38%). We consider that the optimal period for harvesting was exceeded.

Figure 1. *Camelina sativa* GP 202 variety, Calarasi County, 31 May 2012

Figure 2. *Camelina sativa* GP 202 variety, Arad County, 3 June 2012

In Satu-Mare, only a part of trial was infested with *Peronospora camelinae* (Figure 3, 4). No phytosanitary treatments were applied. In Satu-Mare with low inputs application, 1.2 t/ha were obtained. The seed oil percentage was the best from all locations (32.95%). Therefore, *Camelina sativa* is not a demanding plant but its cultivation technology requires further study.

Figure 3. Satu Mare County-Plants infested with *Peronospora camelineae*, 2 June 2012

Figure 4. Satu Mare County – General aspect of *Camelina sativa* crop, 2 June 2012

In Iasi County, the harvesting was done at the right time and the losses were minimal. The most predominant weed was *Chenopodium album* but after treatment it was eliminated (see Figure 5). The seed oil percentage was higher for GP 202 variety (28.91%) and lower for the GP 204 variety (23.88%). The best obtained yield, 2.9 t/ha was obtained for *GP 202* variety. For *GP 204* variety, 2.2 t/ha were obtained.

Figure 5. *Chenopodium album* in camelina crop, Iasi County, 07 June 2012

In Calarasi, the harvesting was done using a combine with minimum air flow. Also, the harvesting was done too late. Especially in Calarasi county plants are harvested earlier than in other regions. No dessicant was applied. The first capsules containing high amount of seeds matured earlier and were the first to shake. It is necessary to identify the optimum harvesting period. The gross production for each variety was 1.8 t/ha for *GP 202* and 1.2 t/ha for *GP 204*. The seeds had 25.23% oil content for *GP 202* variety and 22.23% for the *GP 204* variety.

CONCLUSIONS

The technology of camelina cultivation is a complex one which needs attention by the farmers, although the plant itself is not a demanding one.

The best obtained yield, 2.9 t/ha, was obtained in Iasi for *Camelina sativa* GP 202 variety.

We consider that the harvest occurred too late in the South of Romania when the yields are harvested earlier than the rest of the country. It is necessary to identify the optimal harvesting date.

The seed oil percentage was higher for GP 202 variety and lower for the GP 204 variety.

The crops that are sowing later in spring mature non-uniformly, leading to yield losses.

We consider that both *Camelina sativa* varieties (*GP 202* and *GP 204*) meet the growth and development conditions for Romania.

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